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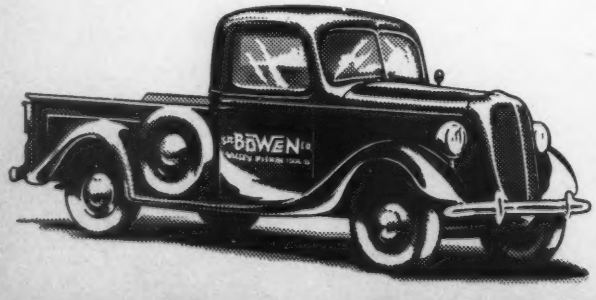

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THE WORLD'S FIRST OIL TRADE PUBLICATION

JANUARY 5, 1937
VOL. 30 • NO. 1
WHOLE NO. 1480

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COMING EVENTS

January 11-15
American Road Builder's Assn., Highway Exhibit and Convention, New Orleans.

January 11-15
Society of Automotive Engineers, Book-Cadallic Hotel, Detroit, Mich.

January 12
Meeting of the Basin Chapter, A.P.I.

January 12
Mining & Metallurgical Society of America, New York.

January 16-24
First International Consumers Petroleum Exposition, Convention Hall, Detroit, Mich.

February 8-10
Kentucky Petroleum Marketers Assn., Tenth Annual Meeting, Brown Hotel, Louisville.

California Oil World and Petroleum Industry is published twice a month at 536 Petroleum Securities Bldg., 714 West Olympic Blvd., Los Angeles, California. Entered as Second-class Matter October 28, 1936, at the post office at Los Angeles, California, under the Act of March 3, 1879. Subscription price: $1 per year in U. S. and possessions, $2 in foreign countries, including Canada. Member of the Audit Bureau of Circulations.

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Editorial

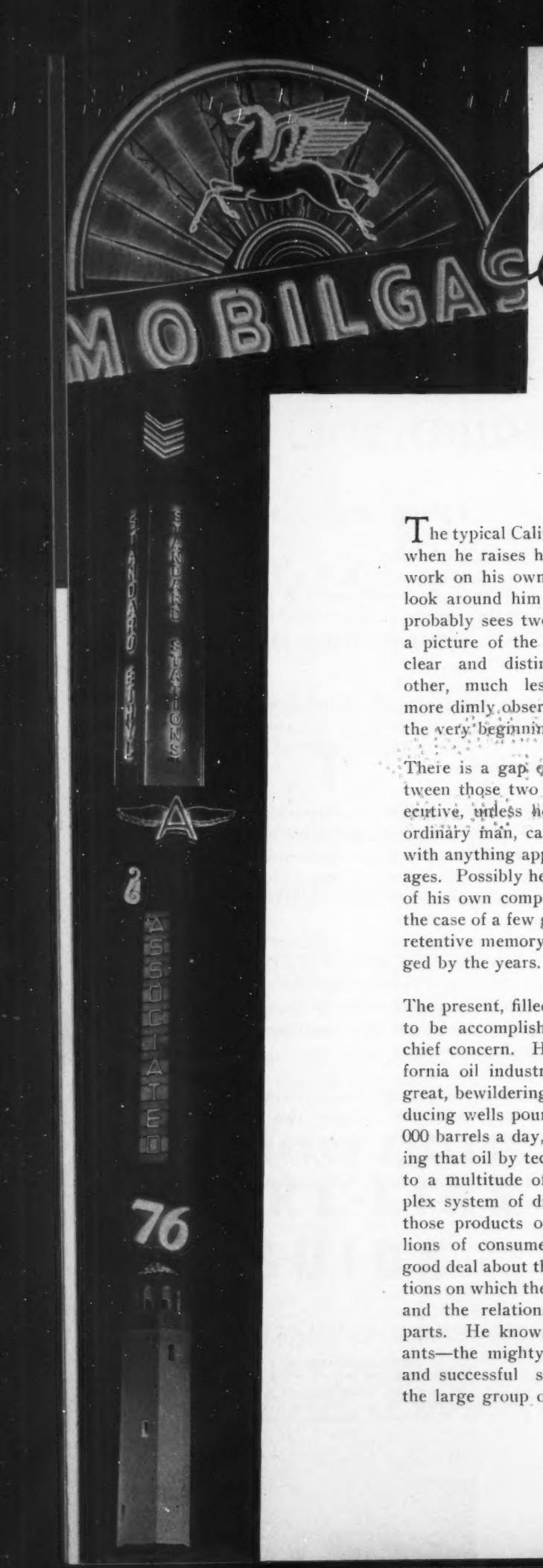
The State Board of Equalization, in its present drive to stop producers from using "drip" gasoline on their leases, is entirely within the letter of the law. Whether it is within the spirit of the law is an entirely different question.

Such gasoline has been used on leases for years. It has been used to clean clothes, to clean tools, and for any other purpose for which gasoline is used, including the running of internal combustion engines. It is not good motor fuel, but it can be used as such.

However, the Board has, in most cases, presented assessment bills to operators without the operator's knowledge that he was liable for assessment, and without the operator's knowledge that, within the meaning of the law, he was a distributor of gasoline, and, therefore, subject to the laws governing the licensing of distributors of gasoline.

To the extent that the Board has crept up on the operator, and has given him no warning of his infraction of the law, the California Oil World considers the present campaign unfair, and believes that the operator is entirely justified in his claim that here is another case where too many laws spoil a good business, to paraphrase an old saw about too many cooks and their effect upon the broth.

The California Oil World sincerely recommends to all operators a careful scrutiny of the state "Motor Vehicle Fuel License Tax Act" so that they may determine whether, under the terms of the act, they are liable for assessments upon "drip" gasoline. A good rule of thumb is that, if there is drip gasoline on the lease, the operator is a distributor, and, as such, is liable for a tax upon that gasoline.



Service

The typical California oil executive, when he raises his eyes from the work on his own desk and takes a look around him at his industry, probably sees two pictures. One is a picture of the present, visible in clear and distinct outlines. The other, much less detailed, much more dimly observed, is a picture of the very beginnings of the industry.

There is a gap of a generation between those two pictures. The executive, unless he is a most extraordinary man, can not fill that gap with anything approaching clear images. Possibly he knows the history of his own company, but except in the case of a few graying veterans of retentive memory, even that is fogged by the years.

The present, filled with urgent jobs to be accomplished today, is his chief concern. He knows the California oil industry as it exists—a great, bewildering panorama of producing wells pouring out their 600,000 barrels a day, refineries converting that oil by technical miracles into a multitude of products, a complex system of distribution rushing those products out to tens of millions of consumers. He knows a good deal about the financial foundations on which the industry operates, and the relationships between its parts. He knows its corporate giants—the mighty majors, the alert and successful smaller marketers, the large group of important enterprises which supply the industry's needs. He knows the men who sit in the seats of authority in those companies.

The other picture—the beginnings of petroleum—seems too remote to concern him. He remembers having read of Colonel Drake and Oil Creek, and the 69-foot well from which flowed a reorganized civilization. He may recall the names of a few men who brought the industry to California—such men as D. G. Scofield, Lyman Stewart or John Barneson. He may even be able to tell a few incidents of the early days of California petroleum—E. L. Doheny fingering a handful of greasy earth and tracing it to its origin, where he started to dig for it with pick and shovel—Hardison and Stewart, nearly bankrupt after four failures, finding success in Pico Canyon—J. M. Elwood, sinking a water well 75 feet on the banks of Kern River and starting an oil rush. But what came *in between* those incidents and the great companies into which they developed? How did Elwood's water well evolve into the present Associated Oil? How was Union built from Stewart and Hardison's first crude derrick? What followed Doheny's instinctive recognition of the treasure locked beneath the tarry soil? How did Standard Oil of California grow out of the company Scofield organized in 1875?

Few executives who are now active

in the industry can answer those questions, tracing the rise of the Great Names of California petroleum. Between the dim picture of the very beginning and the vivid picture of today there is no link.

Why should there be? Isn't history pretty dull? Hasn't the busy oil man enough to do in keeping abreast of today and anticipating tomorrow? What's the use of knowing the steps by which certain companies made their way to gigantic success?

The California Oil World sincerely believes that the answers to these questions will make a story of absorbing interest to the people who make up the oil industry of the Pacific Coast. The publication has commissioned me to write, for its readers, a series of articles, giving an analytical history of leading corporations of the California oil industry. The California Oil World knows that, while some history is dull, the story of these companies is crowded with adventure and packed with fascinating exploits. Moreover, the story must be written now —or not at all—because the men who carried the load, and created the industry, will not be here forever to recount their experiences. Further (if the story-teller is worthy of his story) the record of the development of these companies will interest every reader, junior or veteran, who is connected with the petroleum industry.

But neither the California Oil World nor I believe that busy oil men want to read such stories for adventure or historical value alone. This series must have its direct value for today and tomorrow, for these are built on yesterday. Only through an understanding of how we arrived where we are can we soundly set our course for where we are going.

Walter C. Monroe, president of California Oil World, has told me, therefore, to dig into the histories of these companies with *today's* problems in mind—to trace, from their first appearance, trends which are still at work—to show how success followed from vision, judgment and courage, which are still effective in like situations.

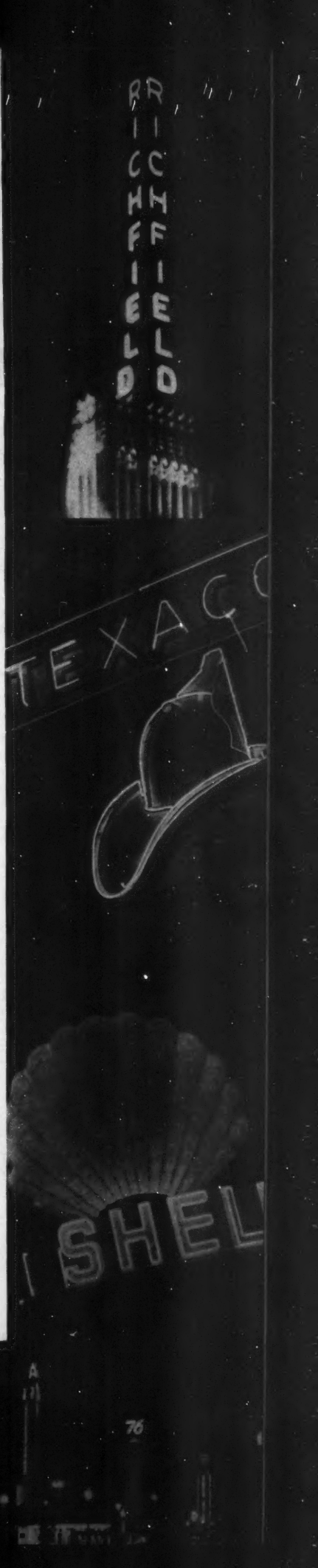
This series, then, will give the readers of California Oil World no dead history, but pictures of the concerns which are leaders, in specific terms of *how they got that way.*

This is no small task, for the writer or for the magazine. It will require the full and frank assistance of the companies that are described; it will involve long hours spent searching their records; it will demand many conversations with the remaining pioneers who can look back and draw on their personal experiences. It will necessitate a nice discrimination between the essential and the trivial, a careful selection of vital facts.

But it is a task richly worth doing. California Oil World, the oldest oil trade publication in the world, in cooperation with Mitchum, Tully and Company, California investment bankers, will attempt it as a part of its greater service as a modern trade publication.

We start, in an early issue, with the first of these articles—an account of the beginnings of a great company which has done much to shape the growth of the entire industry.

DOUGLAS G. McPHEE.



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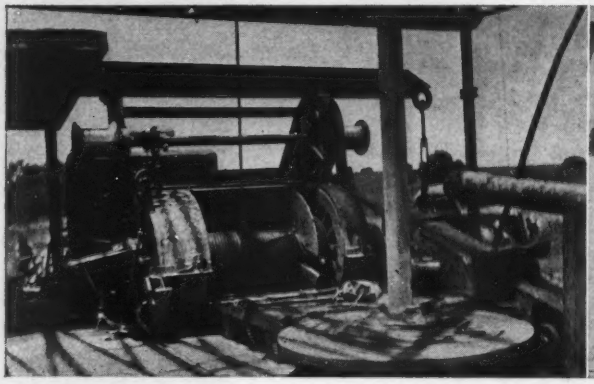

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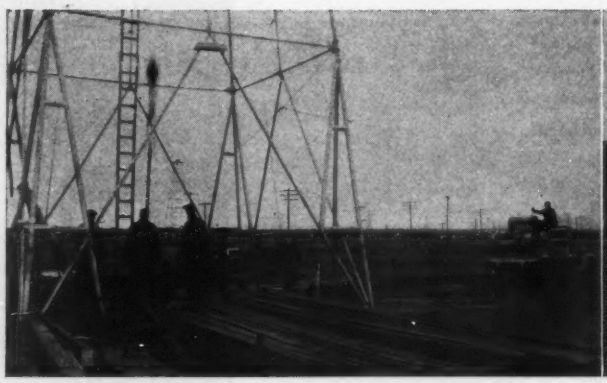

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Production

Influence Of Production Practice On The Gravity Of Oil

By R. R. Boyd
Richfield Oil Co.

A paper before the Oct. 1-2 meeting of the A. I. M. E., at Los Angeles, California.

The gravity here discussed is that of the clean oil produced. Gravities of fluids containing water, free or in the form of emulsion, sand, drilling mud or mineral salts of a non-bituminous nature do not represent the gravity of crude oil as considered in this paper.

During recent years it has become a frequent occurrence for operators to be called upon to explain to landowners the reasons for variations in gravity on shipments of oil from wells in which they are interested as royalty owners. In case of single well leases it has been noted that marked changes in gravity frequently occurred for no apparent reason. Data when collected on the subject and correlated with production methods reveal considerable of interest. It is the purpose of this paper to present some of the highlights on the subject.

These gravity changes in the natural crude oil are with a few exceptions the result of the liberation under varying conditions of the volatile hydrocarbons from the natural oil-gas solution contained within the pool. The subject of the liberation of gases from natural oil-gas solution has been investigated by Ben E. Lindsly of the U. S. Bureau of Mines, and the observations here noted are in the main consistent with his conclusions.

Investigators have recognized two methods of liberation of gas from solution—flash and differential. In the latter method the vapors are removed from the liquid as rapidly as formed and have no opportunity to come to a condition of equilibrium with the oil. In flash liberation an equilibrium condition between the oil and the gas exists at the pressure of separation. Mr. Lindsly has found that the method of liberating the gas from the oil has a pronounced effect on the final gravity and that differential liberation results in a higher A.P.I. gravity due to the higher ratio of gasoline producing hydrocarbons left in the oil.

Under actual production practices with high velocities in flow strings, it is our contention that conditions of perfect equilibrium between gas and the oil rarely exist, and that gas separation is made under varying conditions, sometimes approaching that of equilibrium and at other times departing from it.

It has been pointed out that the gravity of the oil-gas solution in a natural reservoir under pressure is much lighter due to the dissolved gas than is the gravity of the oil as delivered to the production tanks. From a production standpoint it is desirable to distinguish between the gravity of the oil-gas solution in the reservoir and that of the oil component. As the gravity of the residual oil will vary with the changing conditions under which the gas component is liberated, we may define the gravity of the oil within the reservoir as the gravity of the liquid hydrocarbon content of the reservoir when reduced to atmospheric pressure under conditions of differential liberation. We may not be able to measure this gravity accurately unless we get a bottomhole sample under static conditions, but we nevertheless shall adopt the definition.

A discussion covering the changes in gravity of crude oil brought about through methods of production involves two separate phases;

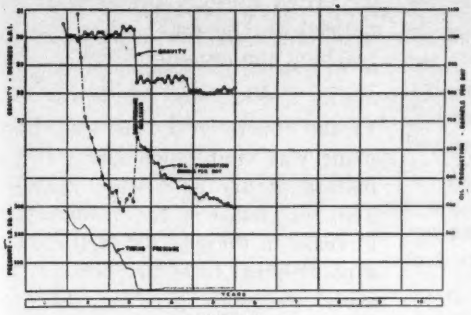
1. The gravity changes of the fluid within the reservoir.

2. Gravity changes brought about in the wells, lines, and traps, by the methods of operations.

Gravity Changes Within the Reservoir

Gravity changes within the reservoir may be brought about by migration. A decrease in the gravity of the oil in an old field under water drive is a common phenomenon. In a few cases an increase in gravity has been noted after prolonged periods of pumping which may be ascribed to a downright migration of lighter oil originally accumulated on the top of the structure, the downward migration having been caused by edge withdrawals.

The method of gas liberation in the reservoir naturally has a bearing on the gravity of the oil entering the well. Without arguing whether or not this method more nearly approaches flash liberation or is ap-



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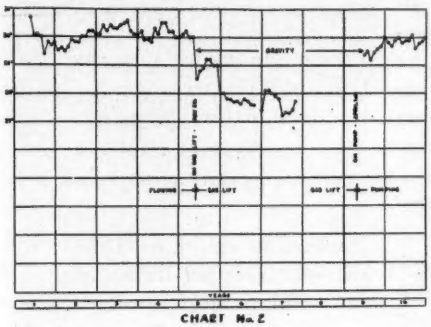

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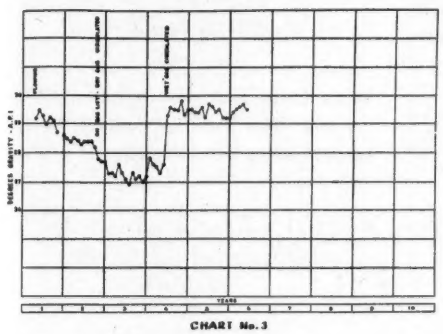

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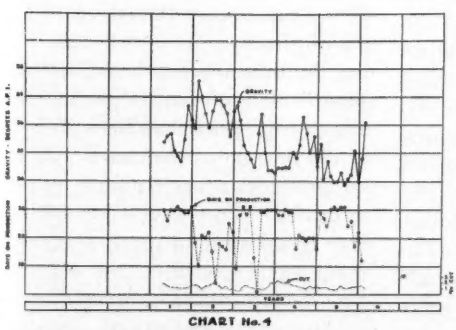

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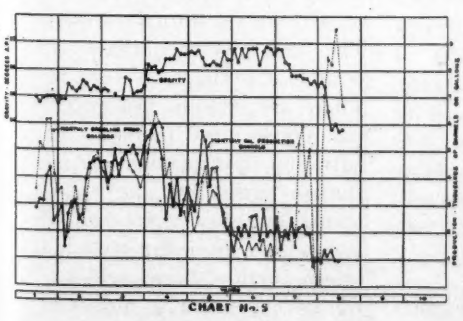

CHART No. 5

proximately differential liberation, we can admit that it varies between the two methods, and also that it is influenced by the position of the well on the structure, the presence or absence of a free gas cap and the method of pressure control on the well.

Gravity Changes Brought About by Producing Operations

It is obvious that an increase in casinghead gasoline from the well must result in the lowering of the gravity of the oil produced except in cases where such gasoline is recovered from a product which was previously lost or where it is drawn from oil still left in the ground. In the first instance the economic gain is clear. In the second an ultimate loss is indicated as casinghead gasoline produced from the oil left in the ground necessarily lowers the gravity of the oil remaining thus lowering its value and making its recovery more difficult.

It often happens that a justification of a change in production is based on an increased gasoline recovery from the gas produced with the oil. Except in cases noted above, increased casinghead gasoline production can occur only when such gasoline is taken directly from the oil produced, thus lowering the gravity and its value, the net results to the operator remaining substantially the same. Changes in gravity of as much as 4° A.P.I. on 30° oil have been brought about by operating practices within the control of the operator. The changes in gravity were accompanied by an equalizing change in natural gasoline production. The producer is primarily interested in producing the maximum amount of oil at a minimum cost, and is not greatly concerned with the effect of his production method on the gravity of the oil as long as the gasoline producing fractions are all recovered in the gasoline plant.

There are some reasons, however, why we should have a better understanding of the causes of these gravity fluctuations, among them the following:

1. Gasoline production may be erroneously credited to an operation which has merely resulted in extracting the gasoline from the oil produced.

2. Geologists may err when using gravity data as an aid in determining the horizon from which the production is originating.

3. Claims have arisen for the improper accounting of royalties, based on the theory that the gravity of the produced oil varies uniformly with the time the well has been on production.

4. A knowledge of the subject may enable the producer to use the gravity data as an aid in solving production problems, including those which have to do with reservoir withdrawals.

The gravity figure used is that sented covering changes in gravity which have resulted from changes in well operations.

The gravity figures used is that of the average of all tank gravities for each month, and unless otherwise noted, represents the gravity of oil cutting 1% or less in M. & B. S.

Chart I—Effect of Release of Pressure on the Well Head

This chart shows the result of a sudden drop in well head pressure. On this chart, in addition to the gravity range has been

platted oil production in barrels per day and the back pressure on the flow string. Through the first twenty-one months of the life of the well, the tubing pressure dropped from 290 pounds per square inch to 70 pounds with little change in the gravity of the oil. The gas was separated in a trap carrying 5 to 10 pounds. The gas-oil ratio varied considerably, gradually making two complete cycles between 1500 and 2300 cu. ft. per barrel. With 60 pounds carried on the tubing, the well ceased to flow. The choke was removed and the well was placed on production by means of the gas lift, which was immediately discontinued. The well continued to flow against 5 to 10 pounds pressure carried on the trap.

The results were as follows:

	Before Change	After Change
Well Head Pressure	70 lbs.	10 lbs.
Trap Pressure....	10 "	10 "
Gas Oil Ratio Cu. Ft. per bbl.....1240		1726
Saturation of gas gals. of gasoline per M. C. F.....	2.81	4.01
Gallons Natural Gasoline per bbl. oil	3.48	6.92
Gravity of oil in flow tank.....30.3°		28.4°
Barrels of oil per day	412	650

Chart II—Effect on Gravity of Changing from Flowing to Gas Lift Operations

On this chart we have a clear record of the effect on the gravity of placing a flowing well on gas lift. During the four year flowing life the gravity ranged between 29.4° A. P. I. and 30.7° A. P. I. As a probable cause of varying gravities, one might suggest the varying conditions of equilibrium within the flow string and in the drainage area immediately surrounding the well. The highest gravity was observed on the first month of production and the lowest on the fifth month. This low point was followed by a steady increase for two years. When the well was finally placed on gas lift, there was an immediate drop of 1.5° in gravity. The low point observed under gas-lift operations was 27.2°. Under pumping operations the gravity again reached 30.0° with an average over a considerable period of time of 29.8°.

The effect of the gas lift is not always immediately noticeable. Usually its application increases the pressure against the formation so that more gas is retained in solution as the oil enters the well. This may partially neutralize at first the effect of the introduction of the dry gas.

The example shown is typical though we have seen cases where the introduction of a small amount of dry gas into a naturally flowing well was not immediately followed by a noticeable change in gravity. The usual drop did take place later however when the quantity recycled was increased.

Chart III—Effect of Substituting Wet Gas Circulation for Dry Gas in Gas Lift Operations

This well was brought in with a highest observed gravity of 29.5° A. P. I. and a gas-oil ratio of 1880 cu. ft. per bbl. The gasoline recovery was 1.58 gallons per 1000 cu. ft., making about 2.84 gallons of natural gasoline recovered per barrel of oil. Production was started with the compressor, but the well flowed without aid after once started. The tubing pressure dropped from 475 pounds to 125 pounds in 25 days, and to 35 pounds before the well went on gas lift. The gas-oil ratio had a uniform increase to 2300. 3 lbs. to 5 lbs. was carried on the trap. The gasoline recovery increased to 1.93 gallons per thousand or 4.43 gallons per barrel of oil. Wax trouble in the upper part of the tubing became serious during the second year.

Under dry gas circulation, the gravity varied considerably as you have noticed on several other charts, reaching a minimum of 26.9° A. P. I.

In the fourth year, the absorption plant was shut down and wet gas instead of dry gas was recycled. This was followed by an immediate increase in the gravity of the oil to a point equal to or in excess of the initial observed gravity. The effects of the change were as follows:

Production under dry gas circulation—bbl. oil per day 129.4
Bbl. natural gasoline 13.4
Average total 142.8
Av. gravity crude oil, 27.4°API

Production under wet gas circulation—bbl. oil per day 146.5
Bbl. natural gasoline 6.9
Average total 153.4
Av. gravity crude oil, 29.6°API

Wax trouble in the upper 1000 feet of the flow string ceased entirely under wet gas circulation.

Chart IV—Effect of Producing Wells with Periodic Intervals of Idleness

This chart shows the effect on gravity of shutting in a well and allowing the fluid level to build up on the pump. The oil from this well had a slight cut, which has been indicated at the bottom of the chart. The days on production each month are also indicated. The practice on this well was to allow it to produce its allotment each month. This was done by producing for a sufficient number of days at the end of one month and continuing on into the next month. The well was then closed in for a period of perhaps 20 or 30 days. There are periods, however, of several consecutive months when no curtailment was taken. After each shut-in period, we have the high points on gravity followed by the low points after the well had been on production a few weeks. Where we have continuous production we

have continuous low. This well was shut in at one time while producing 23.8° oil. After being closed in for one month, on being placed on production, successive tanks during the next month had the following gravities: 26.7°, 26.3°, 25.6°, 24.7°, 24.7°, 24.0°.

In contrast to this graph, some pumping wells which are producing continuously show a close approximation to a straight line decline in gravity. One record covering several years of a Brown Zone well, at Long Beach, shows a drop of 1.3° A. P. I. in that time with only ten months where the gravity falls more than 0.2° above or below a straight line drawn between the beginning and end of the record. The extremes in variation are 0.5° above the line and 0.3° below the line.

Chart V—Effect of a Vacuum on the Casinghead

On this graph is platted the gravity by months, the oil production by months in barrels, and the gasoline production by months in gallons. Roughly the relation throughout is one gallon of gasoline per barrel of oil.

The irregularities of the production curve are caused by curtailment. During the period of high fluid levels, the ratio of gasoline to oil drops and the gravity increases.

Production methods of the offsets involved the use of a vacuum, which caused the same method to be used here. As no appreciable improvement was noted in the oil production, the practice was stopped with the result that gas production dropped to zero with no improvement in the oil gravity. The practice was then resumed, resulting the production of 11 gallons of gasoline per barrel of oil, a quantity far in excess of the amount coming from the oil produced. The evil effects are appearing at the end of the graph with a decreasing gasoline production with no improvement in the quantity or quality of the oil produced, which has already been bled of a large part of its gasoline content before it enters the well.

Effect of High Pressure Traps

If the primary separation of gas is made at high pressure we may expect to conserve the gravity of the oil. Mr. Lindsly has discussed this matter at length, so we will merely submit some data on a well which had been producing for some months previous to the installation of the high pressure trap.

	A. P. I. Gravity of Oil	*Gals. of Gasoline produced per bbl. of oil*
Before high pressure trap was used	29.2°	7.38
During use of 360 lbs. trap.....	30.6°	4.56
On gas lift.....	26.6°	11.8

During the later stages of the flowing period we have no gravity data therefore the gas lift data covers a period some two years later than the other data. When the well was later pumped the gravity of the oil was around 30.0° A. P. I.

As a result of the data which we have accumulated, we can conclude that the following operating conditions help to retain the heavier vapor in the oil and therefore conserve its gravity:

Carefully regulated pressure control at the well head.
Primary separation of gas at high pressure.
Use of wet gas in gas lift work.
High fluid levels.
Smooth pumping motion.

Some of the causes of abrupt drop in gravity are as follows:

Marked drops in well head or trap pressures.
Circulation of dry gas for gas lift work.
Low fluid levels.
Poor pump operations.

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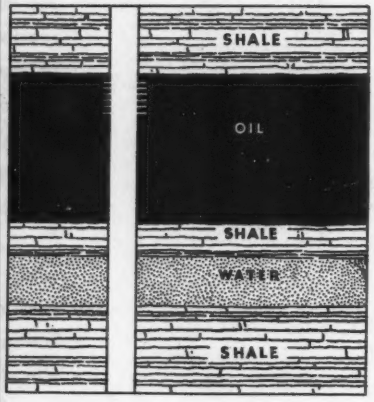

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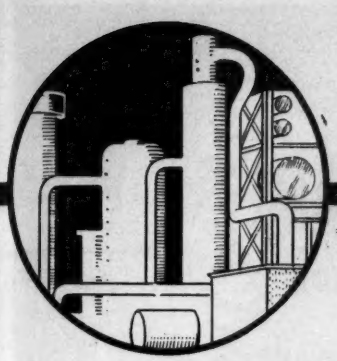
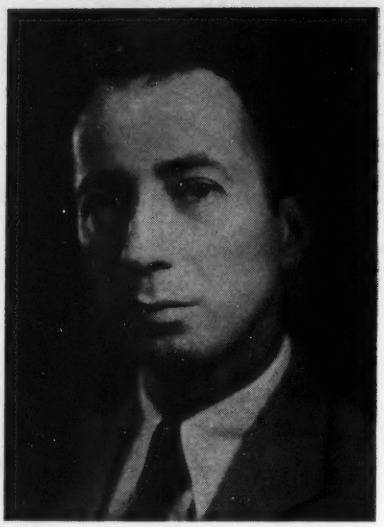


Refining

Motor Fuel Isoparaffins By Gas Polymerization

By F. E. Frey
Phillips Petroleum Co.

A paper before the C. N. G. A. Fall Meeting, Los Angeles, Calif.



Gas polymerization to produce motor fuel is a now familiar development and is of interest to the natural gasoline industry because of the increased volume of gasoline to be obtained from natural gas by the conversion of the normally gaseous butane, propane, and ethane content. Its value to refiners lies in the conversion of still gases with consequent increase in gasoline yield derived from the crude.

Another aspect of gas polymerization which is coming to command increased interest follows from the fact that polymerization, unlike oil cracking, must involve the synthesis of large molecules, that is, gasoline, from small ones, that is, gas, and it thus becomes possible to design and build up at will gasoline hydrocarbons of various types and individual gasoline hydrocarbons of desired characteristics. This is important for producing a suitable fuel to use in internal combustion engines of very high compression ratio, and at the present time the production of aviation gasoline has the center of the stage.

Naturally enough, such a development involves largely hydrocarbon chemistry; process development can with profit take into account the chemistry involved. A hydrocarbon chemist welcomes this opportunity for the aditional reason that it gives him an opportunity to work with simple individual hydrocarbons and unravel the complex reactions they undergo to determine what the reactions are, and how they proceed, and the like which have been veiled in mystery, largely because of the chemical complexity of the materials involved.

This paper deals with an experimental study of the non-catalytic union of paraffins with olefins and the data to be discussed are of interest from both the applied and chemical standpoints. To show where this work belongs in relation to the whole picture it is desirable to review very briefly the various conversion steps involved in gas polymerization.

Two chief classes of hydrocarbons occur in hydrocarbon gas, paraffins and olefins. Natural gas is composed of paraffins, and cracking still gas of paraffins plus olefins. The gaseous paraffins and olefins are not too numerous to name over. The paraffins are methane, ethane, propane, n-butane and isobutane, of 1, 2, 3 and 4 carbon atoms per molecule, respectively. For each paraffin except methane, there exists a corresponding olefin or olefins of similar boiling point and specific gravity, namely ethylene of 2, propylene of 3 and butylenes of 4 carbon atoms per molecule. The olefins have a cracked odor even in the pure state. Furthermore, the olefins differ from the paraffins in being deficient in hydrogen by two hydrogen atoms per molecule, and are sometimes called unsaturates. An olefin molecule can remedy this deficiency by uniting with hydrogen, but can also do so by uniting with other hydrocarbon molecules such as other olefin molecules, and this is called polymerization. Polymerization has been called "making big ones out of little ones."

Of the natural gas hydrocarbons, methane is the most refractory in the polymerization processes. All the other gaseous hydrocarbons can be converted into motor fuel by process steps or combinations of steps to be briefly described. For the most part, reactions involving just the simple or gaseous hydrocarbons themselves fall into the two classes, firstly, splitting or dissociation into smaller molecules, and secondly, synthesis or polymerization in which larger molecules, that is, gasoline, are formed by juncture or combination of smaller ones. The paraffins themselves, being saturated, will not undergo such juncture with each other. Therefore, the function of the splitting type of conversion in connection with gas polymerization is to convert the paraffins into olefins.

Conversion steps applicable in gas polymerization are as follows: Of operations involving splitting, two should be mentioned. Firstly, paraffins may be subjected to high temperature, low pressure cracking which splits the paraffin into olefin plus simpler paraffin and hydrogen. If the reaction is considerably prolonged, benzol and tar are formed. Secondly, the paraffin may be brought into contact with a dehydrogenation catalyst to produce

nearly exclusively the corresponding olefin and hydrogen, with less loss in the form of simple paraffins split out. A catalyst is a substance which causes a reaction to take place without being used up in the process. For example, the clay in a clay tower for treating refinery gasoline vapor is a catalyst which converts gum forming materials into heavy oils which are readily separated from the vapor stream.

Conversion steps of the second type, that is polymerization or synthesis, are also of several sorts. First, olefins may be polymerized non-catalytically, that is, simply by heat and pressure, to gasoline which is largely olefinic but usually contains naphthenes, aromatics and paraffins. The chemistry is quite complex. Secondly, olefins may be polymerized catalytically, and, in the presence of a catalyst, lower temperatures and pressures suffice to bring about reactions producing gasoline. The polymer, or gasoline produced, is composed chiefly of normally liquid olefins under appropriate conditions. The gasoline may be hydrogenated to paraffinic gasoline, and iso-octane can be produced in this way. Thirdly, methods for effecting the direct combination of olefins with paraffins to produce higher paraffins, in the gasoline boiling range, have recently been added to this group. The work of Ipatiev and others has shown that such combinations can be effected catalytically, and the work to be described in this paper shows that it can be effected non-catalytically to produce paraffins of various identities by a suitable selection of conditions. It is notable that such paraffin-olefin juncture allows the paraffin, such as propane or butane, to be incorporated directly and efficiently in the gasoline molecule to produce isoparaffins. Iso-octane is a familiar example of an isoparaffin.

Under suitable conditions it is possible to convert paraffinic gases such as propane and butane, into gasoline in a single conversion step, in which splitting to produce olefins and polymerization to produce gasoline take place at the same time. Keith and Ward[1] have described a unitary thermal conversion process in which gasoline may be produced by heat and pressure treatment in a single reaction zone without the presence of a catalyst. A typical application will serve as an example. Conversion stock is suitably propane and butane, which may be extracted from natural gas, or the corresponding hydrocarbons extracted from cracking still gases which contain, in addition to these paraffins, some olefins. These extracted gaseous hydrocarbons may be handled under sufficient pressure to maintain them as liquids at ordinary temperatures and they are pumped as a liquid to a conversion pressure of 1000 to 3000 pounds per square inch. The liquid under pressure is then passed continuously to a tube coil in a furnace in which it is heated to a reaction temperature of 950° to 1100°F. and allowed to react to the desired degree as it flows through the tube coil. The reacted hydrocarbons are discharged into a fractionating system and three fractions separated, namely, the light gas, largely methane, which is discharged, heavier gases consisting mostly of unconverted propane and butane, plus some C_4 hydrocarbons, which are recycled to the charge pump as liquid, and gasoline. The gasoline contains a very small amount of oil heavier than gasoline which is removed in the fractionating system.

This, in a general way, is one manner in which thermal polymerization is conducted, and the remainder of this paper is devoted to showing how the thermal polymerization reactions can produce isoparaffins of special design. The isoparaffins are of branched structure, as distinguished from normal paraffins of straight chain structure, and a high degree of branching makes for high octane number.

The thermal conversion of saturates under pressure, as just described, particularly propane and butane under 800 to 2200 pounds per square inch, has been the subject of extensive experimental study. It was established that the conversion reactions involved first the splitting of the paraffin into smaller molecules, largely olefins. By reason of the elevated reaction pressure, the olefins so formed were generated under rather high partial pressure and poceeded to polymerize to normally liquid hydrocarbons, the splitting of the original paraffin and the polymerization reactions taking place simultaneously. The propane and butane are not completely converted in a single thermal treatment, and a high partial pressure of paraffinic reactants is accordingly present throughout the conversion period. The gasoline produced was found to contain olefinic polymers and cyclic hydrocarbons such as have been shown to result in the non-catalytic polymerization of olefins under pressure but rather complete analyses of the gasoline disclosed further that isoparaffins were present in considerable amount, constituting the greater part of the gasoline when strictly paraffinic reactants were subjected to thermal conversion at the higher pressures.

It was also found that yields of gasoline obtained, based on propane and butane disappearing, were high, and it was observed that paraffins when admixed with olefins underwent concomitant conversion to produce polymers at conditions too mild for the familiar cracking decomposition. These observations pointed strongly to the juncture of olefins with paraffins as an important polymer forming reaction under such thermal conversion conditions. Furthermore, thermodynamic calculations indicated that such reactions were possible under the existing conditions of temperature and of paraffin and olefin partial pressure.

For the purpose of studying the thermal paraffin-olefin juncture reaction a laboratory investigation has been carried out with the aid of a conversion method designed to permit the alkylation, or paraffin-olefin juncture reaction, to overshadow the

reactions which may take place.[2] An individual olefin, ethylene, was reacted with propane and also with isobutane to determine the identity of the paraffins produced under conditions favorable to primary juncture. This suggested the use of high conversion pressures, ranging from 2500 to 4500 pounds per square inch.

Since in an olefin-paraffin mixture olefins can be expected to polymerize rapidly by olefin-olefin juncture at high partial pressures, and outrun any reaction involving the more sluggish paraffin, means were provided for dispersing the olefin reactant in low concentration in the paraffin reactant before subjecting the mixture to reaction temperature at high pressure. In order to obtain a reasonable extent of conversion, additional olefin was supplied during the reaction as it was consumed, always maintaining the concentration of unreacted olefin at a low level. This effect was obtained on a laboratory scale by charging all the paraffin to be reacted to a closed system consisting of a reaction tube and a circulation pump, then circulating the paraffin while adding olefin during the reaction period, stopping the reaction after the desired amount of olefin had been added, and finally withdrawing the reaction products. This is essentially the same as passing a paraffin through a tube coil at reaction temperature and pressure while injecting olefin at a number of inlets distributed along the tube coil.

Experimental Part

In figure 1 is shown a diagram of the apparatus used in these experiments.

The sample passes from container C (capacity 120cc.) through a short water cooled tube to the Hills-McCanna type G. B. D. pump, from which it is forced through the straight reaction tube A situated in a tube furnace. These reaction tubes were made of 18 per cent Cr - 8 per cent Ni low carbon steel in two sizes; a tube with a bore of ⅛ inch was used for experiment 231-2, and of ¼ inch for the other experiments. A thin, closely fitting copper tube was telescoped inside to eliminate possible catalytic surfaces, and in addition the ¼ inch tube contained a closely fitting twisted copper ribbon to eliminate undesired convection. Oxidation of the copper and subsequent reduction were avoided. The exit end of both tubes contained a loosely fitting solid brass rod to effect the rapid cooling of the effluent gases. The heating coil was divided into three sections under independent control to facilitate maintaining an even reaction temperature. Temperatures were read by means of a chromel-alumel thermocouple at 6 inch intervals along the tube. The furnace was 36 inches in length and the effective conversion zone about 10 inches shorter.

From the reaction tube, the hydrocarbons passed through a water cooler to expansion valve 2 where the pressure was reduced to 100-150 pounds per square inch and into container C, when the cycle was repeated. The time required to cause all the hydrocarbon in the system to flow through the reaction zone depended on the pump setting. Experiments were continued for a time sufficient to permit 10 such cycles. At intervals of two to four times a cycle small definite quantities of olefin were admitted by means of the calibrated tube F and the valves 5 and 6, each increment being a little less than the volume held in the line between 5 and 6 at a cylinder pressure in D of 500 pounds or so.

To observe circulation rate, the flow meter shown at E was employed. This consisted of a small heating coil (about 10 watts) with a sensitive ammeter in series to give close regulation of the heat generated. A six junction copper-constantan thermocouple with the "cold" junctions on the upstream, and the "hot" junctions on the downstream side measured the increase in temperature, and therefore the mass velocity of the hydrocarbon. The whole was heavily lagged. This meter operated satisfactorily, and circulation rates were readily controlled to plus or minus 10 per cent.

The combined sample, consisting of all the reacted material, was then analyzed by means of low temperature fractional distillation in a close-cutting column, combined with Orsat analysis for hydrogen, methane, and olefin determination. Olefins in the larger fractions and in the gasoline fractions were determined by bromine titration. The separation of individual paraffin isomers, which differ in boiling point by small intervals, was effected by observing the usual precautions of analytical fractionation, and in addition maintaining a steady reflux temperature

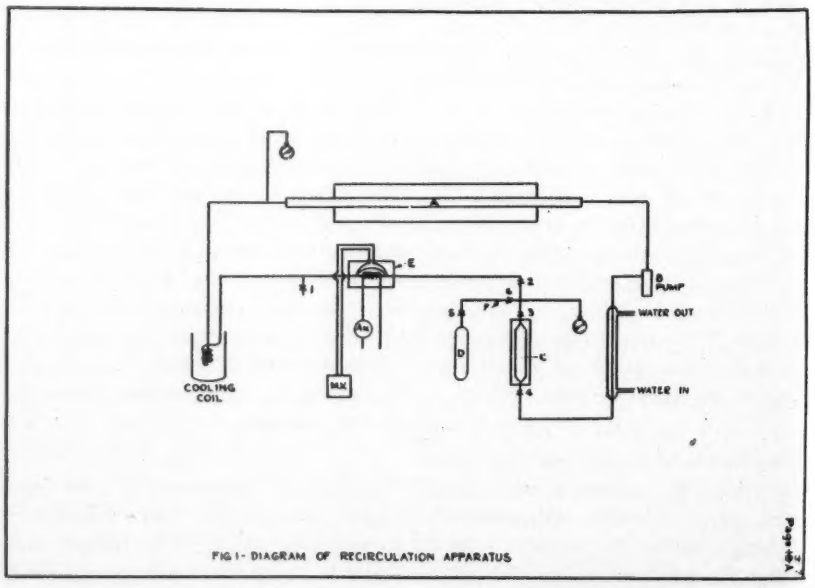


FIG 1- DIAGRAM OF RECIRCULATION APPARATUS

TABLE I

PRODUCTS FORMED BY THE INTERACTION OF PARAFFINS AND ETHYLENE UNDER ALKYLATION CONDITIONS

Experiment No.	231–2	231–3	231–5
Gases Reacted	C_2H_4– 4.7	C_2H_4– 8.9	C_2H_4–12.1
(Weight per cent)	C_3H_8–95.3	C_3H_8–91.1	i-C_4H_{10}–87.9
Pressure (lb./sq. in.)	4,500	4,500	4500
Temperature, °F.	947	950	940
Temperature, °C.	508	510	505
Average reaction time of paraffin reactant (Min.)	3.8	4.1	4.0
Number of olefin additions	40	20	32
Gasoline yield based on products recovered (wt. %)	7.2	11.2	16.3
Products recovered (wt. %)			
H_2	—	0.004	0.013
CH_4	— (a)	0.72	0.94
C_2H_4	1.77	1.23	1.68
C_2H_6	0.34	0.53	0.81
C_3H_6	0.16	0.16	0.56
C_3H_8	89.59	84.40	2.09
iso–C_4H_8	0.39	0.21	0.30
1–C_4H_8		0.80	0.34
2–C_4H_8			0.11
iso–C_4H_{10}	0.0 (b)	0.0 (b)	76.34
n–C_4H_{10}	0.55	0.70	0.54
C_5H_{10}	0.18	0.29	0.81
iso–C_5H_{12}	3.76	6.20	0.53
n–C_5H_{12}	1.67	1.87	0.80
C_6H_{12}	0.12	0.22	0.49
2, 2 dimethyl butane	0.42	0.81	7.20
2–methyl pentane			1.88
n–hexane			0.18
intermed. olefins	—	—	0.08
intermed. saturates	—	—	0.31
C_7H_{14}	—	0.20	0.31
C_7H_{16}	—	1.12	0.43
C_8H_{16}	—	0.12	0.63
C_8H_{18}	—	0.37	1.57
C_9 and up (Uns.)	0.16	0.10	0.38
C_9 and up (Sats.)	0.88		0.68
Total	100.00	100.00	100.00

Note:—(a) The methane determination was lost through an accident.
(b) Less than 10 per cent of the butanes.

TABLE II

PRODUCTS FORMED BY THE INTERACTION OF PARAFFINS AND ETHYLENE UNDER ALKYLATION CONDITIONS

Experiment No.	231–2	231–3	231–5
Cases Reacted	C_2H_4– 8.5	C_2H_4–13.3	C_2H_4–22.
(Mol. per cent)	C_3H_8–91.5	C_3H_8–86.7	1–C_4H_{10}–78.
H/C Ratio of Products	2.39	2.43	2.39
H/C Ratio of Gasoline	2.35	2.33	2.27
Products Recovered (Mol. %)			
H_2	—	0.09	0.39
CH_4	— (a)	2.09	3.30
C_2H_4	2.87	2.07	3.54
C_2H_6	0.64	0.81	1.59
C_3H_6	0.21	0.17	0.78
C_3H_8	91.29	86.60	2.77
iso–C_4H_8	0.32	0.18	0.31
1–C_4H_8		0.67	0.35
2–C_4H_8			0.12
iso–C_4H_{10}	—	—	75.60
n–C_4H_{10}	0.42	0.54	0.54
C_5H_{10}	0.11	0.19	0.67
iso–C_5H_{12}	2.33	4.00	0.44
n–C_5H_{12}	1.04	1.18	0.65
C_6H_{12}	0.07	0.12	0.34
2, 2 dimethyl butane	0.22	0.44	4.94
1–methyl pentane			1.29
n–hexane			0.13
intermed. olefins	—	—	0.05
intermed. paraffins	—	—	0.18
C_7H_{14}	—	0.09	0.19
C_7H_{16}	—	0.52	0.25
C_8H_{16}	—	0.05	0.33
C_8H_{18}	—	0.15	0.81
C_9 and up (Uns.)	0.07 (C_7+)	0.04	0.16
C_9 and up (Sats.)	0.38 (C_7+)		0.28
Total	100.00	100.00	100.00

Note:—(a) The methane fraction was lost through an accident.

and rate of heat input to the distilling bulb, while distilling very slowly. These separations are less precise than the separations between adjacent homologs, however.

Leaks in the system were not entirely prevented. Small losses could not have greatly affected product composition.

Discussion of Data

In Tables I and II are shown the data obtained in a series of three experiments. The product analyses of I and II are in weight and mol per cents respectively. Operating conditions of reaction time and temperature were chosen rather arbitrarily but were such as would permit only slight cracking. The experiments shown give information primarily on the comparative yields and identity of the products obtained from the paraffin-olefin pairs reacted.

Thermodynamic calculations show that considerably higher yields of alkylation product could have been developed by larger olefin additions, and somewhat lower pressures could have been used. The high pressures and moderate conversions were employed, however, in order to favor especially the formation of primary products. With the aid of catalysts lower pressures and temperatures may be used to effect paraffin-olefin juncture and a study of the catalyzed reaction is in progress. The conditions required to effect the thermal reaction are such as to show that alkylation must play an appreciable part in pressure cracking and naphtha reforming operations.

Products

The principal liquid product formed in the experimental conversions was a mixture of isomeric paraffins whose molecular weight was equal to the sum of that of the paraffin and olefin reactants. The yield of this product under the experimental conditions employed was ½ to ¾ of the liquid products formed. The principal alkylation products formed from the two olefin-paraffin pairs investigated are discussed below:

TABLE III

Experiment No.	231-2		231-3	
Gases Reacted (wt. %)				
C_2H_4	4.7		8.9	
C_3H_8	95.3		91.1	
Pressure lb./sq. in.	4500		4500	
Temperature °F.	947		950	
Temperature °C.	508		510	
Average Reaction Time of Paraffin Reactant (Min.)	3.8		4.1	
Gasoline Yield (wt. % of reactants)	7.2		11.2	
Composition of Liquid Products (wt. %)				
	Wt. %	Wt. %	Density (25° C)	RI (20° C.)
C_5H_{10}	2.5	2.6		
iso-C_5H_{12}	52.4	55.5	0.618	1.3551
n-C_5H_{12}	23.2	16.4	0.633	1.3597
C_6H_{12}	1.7	2.0	0.677	1.3952
C_6H_{14}	5.8	7.3		
C_7H_{14}	—	1.8	0.706	1.3970
C_7H_{16}	—	10.1		
C_7 and up (Uns.)	2.2	—		
C_7 and up (Sats.)	12.2	—		
C_8 and up (Uns.)		1.0	0.755	1.4203
C_8 and up (Sats.)		3.3		
	100.00	100.00		

TABLE IV

COMPOSITION OF LIQUID PRODUCTS ETHYLENE AND ISO-BUTANE

Test No.	231-5		
Gases Reacted (wt. %)			
C_2H_4	12.1		
iso-C_4H_{10}	87.9		
Pressure, lb./sq. in.	4500		
Temperature, °F.	940		
Temperature, °C.	505		
Average Reaction Time (Min.)	4.0		
Gasoline Yield (wt. % of reactants)	16.3		
Per cent olefines in gasoline	16.1		
Gasoline Composition	Wt. %	d(25° C.)	RI (20° C.)
Pentenes	4.97		
Iso-pentane	3.25		
n-Pentane	4.91		
Hexenes	3.01		
2, 2 Dimethyl-butane	44.26	0.645	1.3695
2-Methylpentane	11.55	0.655	1.3750
n-Hexane	1.11		
Heptenes	2.39		
Heptanes	4.54		
Octenes	3.87		
Octanes	9.64	0.714	1.3987
Residue (Uns.)	2.33		
Residue (Sats.)	4.17		
Total	100.00		

Ethylene and Propane

Table I and II show conversion conditions and product analyses and Table III shows the composition of liquid products. This is a particularly clean-cut example of alkylation, in that about 75 weight per cent of the liquid products were pentanes, the formation of which can be represented by the equation

$$C_2H_4 + C_3H_8 \rightarrow C_5H_{12}$$

Replacement of secondary hydrogen of the propane by ethyl yields isopentane, while replacement of primary hydrogen yields n-pentane. The pentanes fraction was composed of about 2/3 isopentane and 1/3 n-pentane accompanied by very little pentene, 4 per cent. It is certain that the yields of pentanes permitted in experiments 231-2 and 3 did not approach the thermodynamic limit, and consequently the relative proportions of iso- and n-pentane found reflects the comparative rate of substitution of primary and secondary hydrogen by ethyl, secondary hydrogen replacement proceeding the more rapidly.

Both hexanes and heptanes were formed in substantial amount. At least a part of the hexanes were formed from the reaction of propylene and propane, while the heptanes may have been formed either by secondary alkylation of pentanes with ethylene, or by reaction of butylenes from ethylene polymerization with propane, or both.

Ethylene and Isobutane

In experiments 231-5 (Table I and II) are shown the results of a run at 4500 pounds per square inch wherein ethylene and isobutane were reacted together. The analysis of the liquid products is shown in Table IV. Unfortunately, a fairly large leak occurred during the first 25 per cent of the run near the point of addition of the ethylene, which makes it necessary to use some caution in estimating ethylene consumption.

In general, the reactions occurring are similar to those already discussed. Hexanes are the chief product and constitute 56.9 weight per cent of the gasoline. Their formation can be represented by the equation

$$C_2H_4 + i\text{-}C_4H_{10} \rightarrow C_6H_{14}$$

The substitution of tertiary hydrogen by ethyl yields 2, 2-dimethylbutane, and the substitution of primary hydrogen, 2-methyl pentane. These were the predominant hexanes identified. The fraction designated 2, 2-dimethylbutane distilled almost entirely at 49.5 -50.5°C. (760mm. Hg) and agreed closely in boiling point, refractive index, and density with the reported properties of the synthetic hydrocarbon. The fraction designated 2-methylpentane distilled almost entirely at 60 - 61°C. and agreed closely in these properties with the reported properties of this paraffin. Nearly 80 per cent of the hexane fraction consisted of 2, 2-dimethylbutane.

The rate at which tertiary hydrogen of the isobutane is substituted by ethyl is far greater than the rate for primary hydrogen substitution and the difference is more marked than in the case of secondary vs. primary substitution described in connection with the ethylene-propane juncture. The rate of hydrogen replacement by ethyl in these two instances de-

TABLE V
EFFECT OF PRESSURE AND SINGLE POINT OLEFIN ADDITION ON THE ETHYLENE—ISO-BUTANE CONVERSION

Experiment No.	266–11		266–12		231–5
Gases Reacted (wt. %)					
Ethylene	16.5		9.8		12.1
Iso-butane	83.5		90.2		87.9
Pressure (lb. per sq. in.)	4,700		2,500		4,500
Temperature, °F.	941		968		940
Temperature, °C.	505		520		505
Average Reaction Time (Min.)	5.1		4.3		4.0
Experimental method	Single pass		Recirculation		Recirculation
Gasoline Yield (wt. % of effluents)	20.4		12.8		16.1
Composition of Products (b)	Mol. %	Wt. %	Mol. %	Wt. %	Wt. %
Hydrogen	3.48	2.34	1.28	0.05	0.013
Methane			10.35	3.09	0.94
Ethylene	0.28	0.13	1.97	1.03	1.68
Ethane	5.14	2.68	4.64	2.62	0.81
Propylene	1.05	0.76	2.21	1.72	0.56
Propane	3.83	2.98	3.71	3.12	2.09
Butylene	2.35	2.26	2.22	2.32	0.75
Iso-butane	66.14	67.97	65.35	72.53	76.34
n–Butane	0.44	0.45	0.64	0.71	0.54
Pentenes	0.73	0.89	0.56	0.73	0.81
Iso–pentane	0.53	0.68	0.48	0.66	0.53
n–Pentane	3.32	4.18	1.17	1.54	0.80
Hexenes	0.37	0.55	0.36	0.58	0.49
2, 2 dimethyl-butane	0.72	1.08	1.98	3.22	7.20
Other hexanes	1.65	2.50	1.15	1.88	2.06
Heptenes	0.13	0.22	0.18	0.32	0.39
Heptanes	0.65	1.14	0.53	1.01	0.74
Octenes	0.35	0.69	0.21	0.50	0.63
Octanes	1.76	3.52	0.48	1.03	1.57
Nonanes+	1.79	4.19	0.29	0.71	
Residue	0.29	0.79(a)	0.24	0.63(b)	1.06
Total	100.00	100.00	100.00	100.00	100.00

Notes:—(a) 0.15 Wt. per cent of carbon was found in test 266–11.
(b) The carbon-hydrogen ratio of products in tests 266–11 and 266–12 is low. This factor is sensitive to small analytical errors, and will not affect largely the conclusions drawn from the analyses shown.

TABLE VI
COMPOSITION OF LIQUID PRODUCTS ETHYLENE AND ISO-BUTANE AT 2,500 LB. PER SQ. IN.

Experiment No.	266–12			
Gases Reacted (wt. %)				
Ethylene	9.8			
Iso-butane	90.2			
Pressure lb. per sq. in.	2,500			
Temperature, °F.	968			
Temperature, °C.	520			
Average Reaction Time (Min.)	4.3			
Yield of Liquid Products (wt. %) (Based on products recovered)	12.8			
Composition of Liquid Products	Mol. %	Wt. %	Density (60° F.)	Density (25° C.)
Pentenes	7.3	5.7		
Isopentane	6.3	5.2		
n–Pentane	15.3	12.0		
Hexenes	4.7	4.5		
2, 2 dimethyl-butane	25.9	25.2	0.660	0.652
Other hexanes	15.2	14.7	0.690	0.682
Heptenes	2.4	2.5	0.722	0.714
Heptanes	6.9	7.9		
Octenes	2.8	3.9	0.748	0.741
Octanes	6.3	8.0		
Nonenes and heavier (Unsat.)	2.0	2.9	0.804	0.798
Nonanes and heavier (Sat.)	3.3	5.0		
Residue	1.6	2.5		
	100 0	100.0		

creases in the order tertiary → secondary → primary, and it is probable that the comparative rates found will indicate what is to be expected in the thermal ethylation of other paraffins.

The heptanes and octanes, which constitute the chief higher products probably resulted both from the direct alkylation of isobutane with propylene, and other secondary reactions.

Conversion Pressure

Very high pressures as contrasted with low pressures can be expected to favor primary paraffin-olefin juncture, while lower pressures can be expected to favor alkylation involving olefin polymers as well. An experiment (266-12) in which ethylene and isobutane were caused to react at 2500 pounds per square inch is reported in Table V and the liquid product analyses in Table VI. For comparison the experiment at 4500 pounds per square inch (231-5) is also included. While the effects of thermal decomposition are evident, due to the more severe time-temperature conditions employed at 2500 pounds, yet the alkylation reaction proceeded in about the manner to be expected if the alkylation reaction were of about the second order. The proportion of hexanes (primary alkylation products) in the gasoline was decreased somewhat by the lower pressure, but the composition of these hexanes was but little affected.

Circulation vs. Once-Through Conversion

In Tables V and VII are shown the results of an experiment (266-11) wherein a mixture of ethylene and isobutane was passed, without recirculation, through a heated tube, that is, subjected to simple once-through conversion. For comparison experiment 231-5 at 4500 pounds pressure, wherein the ethylene was added in small increments throughout the experiment, is also shown in the tables. The time, temperature, pressure and per cent gasoline produced are roughly similar.

The quantity of liquid products formed is definitely greater than the ethylene contained in the hydrocarbons reacted in both cases. The proportion of high boiling compounds in the liquid products is definitely the greater in the case of once-through conversion in comparison with circulation conversion, under conditions otherwise similar. The proportion of hexanes (primary alkylation products) in the gasoline formed in once-through conversion is only about one-third that formed in the recirculation experiment and

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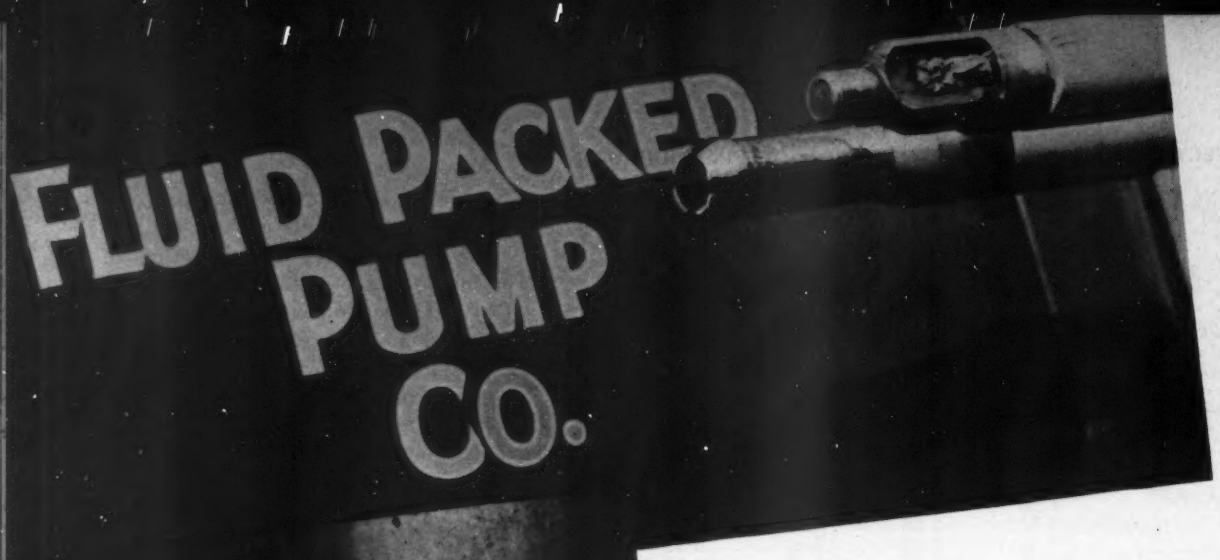

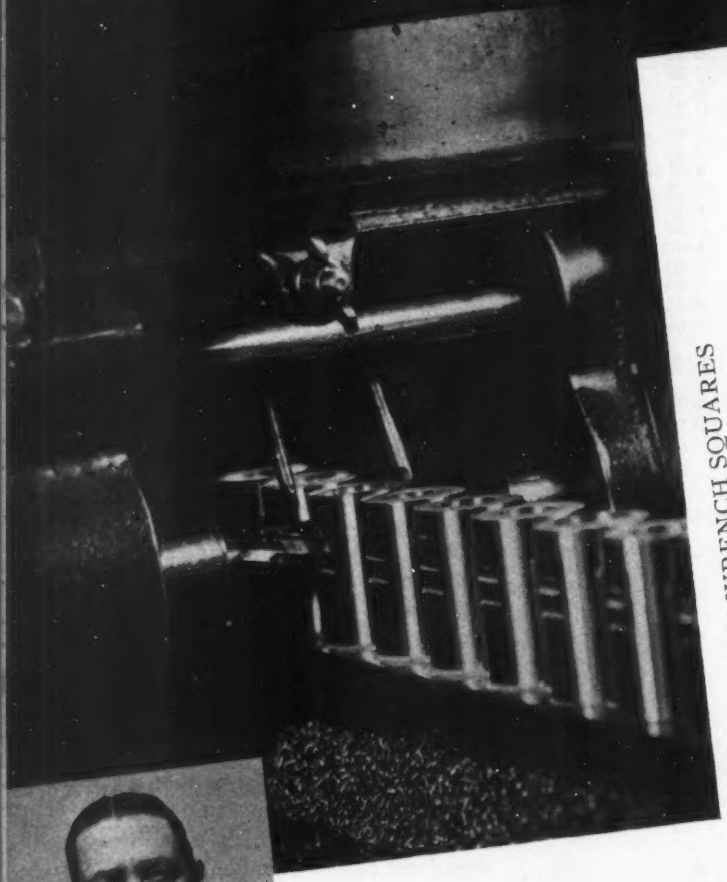

MILLING WRENCH SQUARES

● The milling machine is an Aladdin's Lamp that has helped to lower manufacturing costs and bring about a much desired standardization of parts. It, too, can be tooled to do a number of things; in this operation it is placing wrench squares on the outside of the tubing to facilitate assembling in shop or field.

● Old-timers in the manufacturing business never fail to marvel at the automatic lathe—another miracle worker of modern industry. On this machine are formed the many small parts that make a completed pump. The installation is first tooled to turn out the part desired, then four bars of steel, each twenty feet long, are placed into the maw of the machine, the switch is thrown and without further human attention it automatically machines the outside diameter of one piece after another, drills out the core, cuts the part to the desired length and sends it sliding down a spiral chute ready for the assembly room.

● No part is finished until it is inspected. At right we see an inspector lining up a plunger destined soon to become part of a new groove seal pump.

The job is finished—and the pumps are loaded on the truck and ready for the crew.

● J. B. Reilly, president, who has spent all his working years in the California oil business.

● F. R. Norris, manager, who added his services to the organization in 1925.

● E. M. Rees, sales manager, who first joined the company in 1928.

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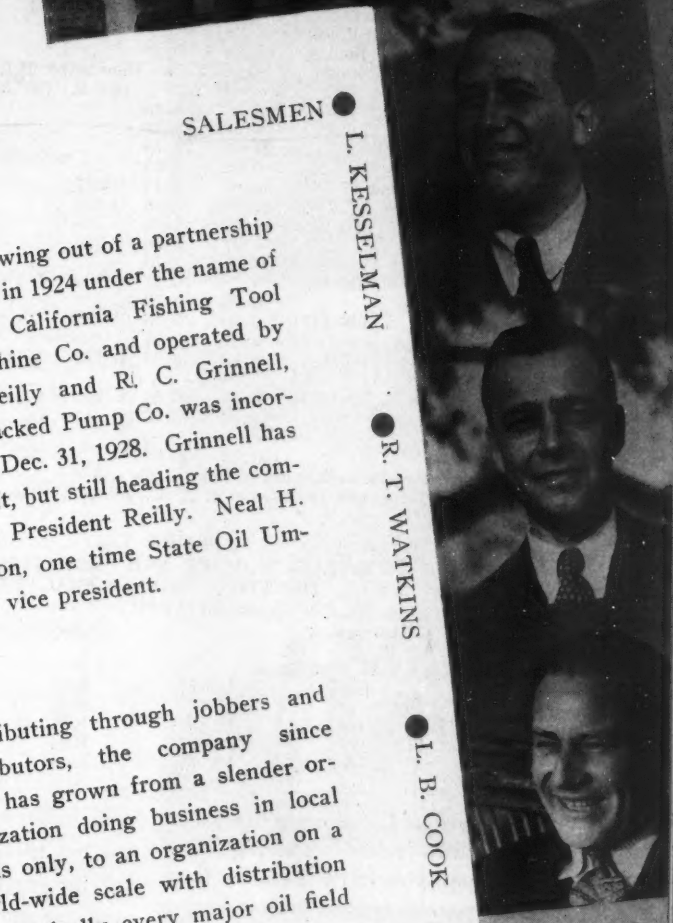

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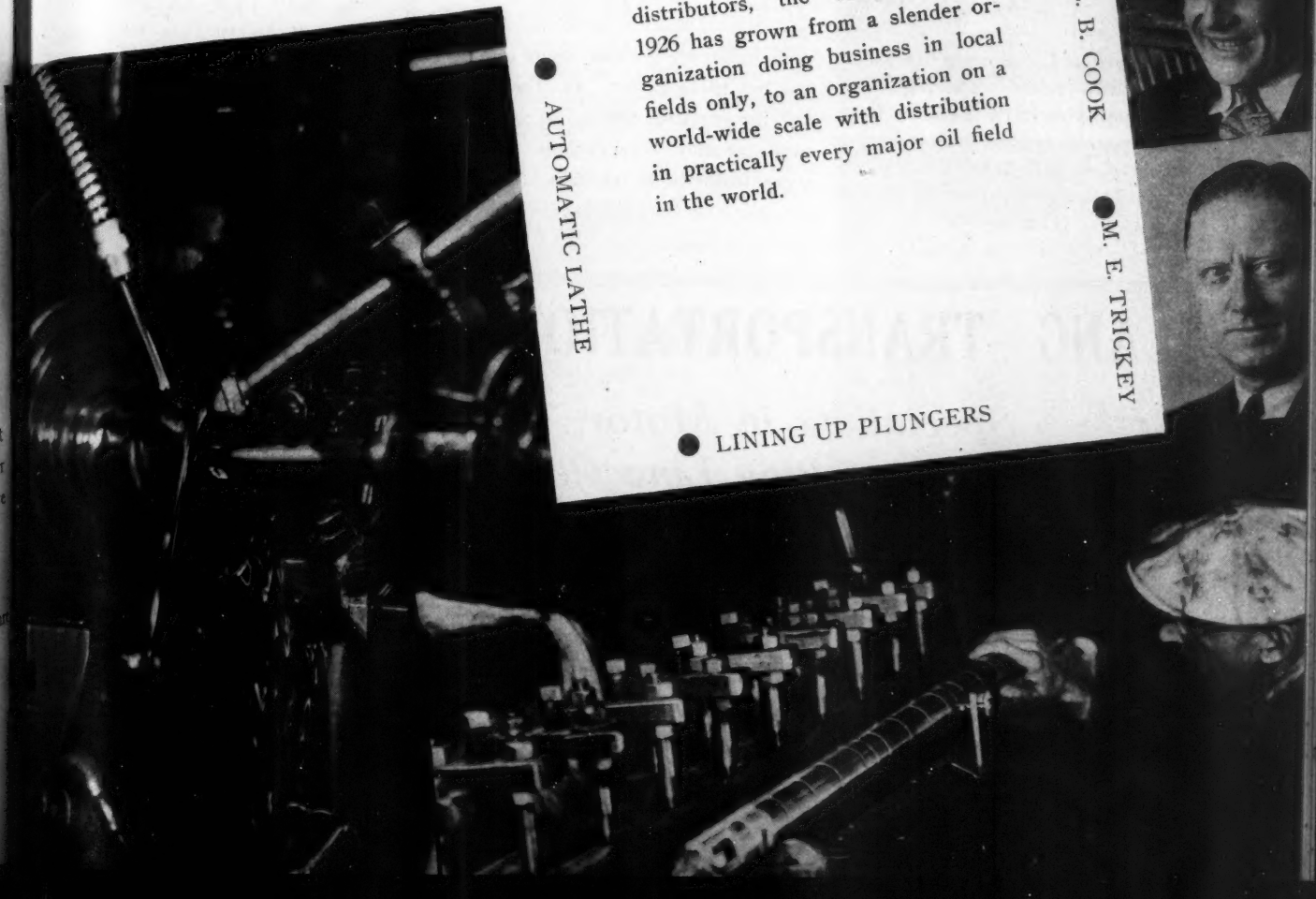
Growing out of a partnership organized in 1924 under the name of Southern California Fishing Tool and Machine Co. and operated by J. B. Reilly and R. C. Grinnell, Fluid Packed Pump Co. was incorporated Dec. 31, 1928. Grinnell has since left, but still heading the company is President Reilly. Neal H. Anderson, one time State Oil Umpire, is vice president.

Distributing through jobbers and distributors, the company since 1926 has grown from a slender organization doing business in local fields only, to an organization on a world-wide scale with distribution in practically every major oil field in the world.



AUTOMATIC LATHE

LINING UP PLUNGERS

TABLE VII
COMPOSITION OF LIQUID PRODUCTS
ETHYLENE AND ISO-BUTANE

Run Number				266–11			231–5	
Charge Stock (wt. %)								
Ethylene				16.5			12.1	
Iso-Butane				83.5			87.9	
Pressure Lb./sq. in.				4,700			4,500	
Temperature, °F.				941			940	
Temperature, °C.				505			505	
Average Reaction Time (Min.)				5.1			4.0	
Experimental Method				Single pass			Recirculation	
Yield of Liquid Producrs				20.4			16.3	
Composition of Liquid Products								
	Boiling Range °C.	Mol. %	Wt. %	Density(b) (60° F.)	R.I. (20° C.)	Wt. %	Density(b) (60° F.)	R.I. (20° C.)
Pentenes		5.94	4.35			4.97		
Iso-pentane		4.31	3.32			3.25		
n–Pentane		27.00	20.48			4.91		
Hexenes		3.01	2.69			3.01		
2,2 dimethyl butane	47–52	5.86	5.28	0.667		44.26	0.652	1.3695
Other hexanes	52–80	13.44	12.26	0.691		12.66	0.663	1.3750
Heptenes	80–93	1.06	1.08			2.39		
Heptanes		5.27	5.38	0.709		4.54		
Octenes		1.41	1.70					
Octanes	103–108	8.78	10.51	0.732	1.4108			
Octenes		0.58	0.70			3.87		
Octanes	108–117	2.88	3.45	0.746	1.4080	9.64	0.722	1.3987
Octenes		0.81	0.97					
Octanes	117–128	2.73	3.27	0.786	1.4305			
Nonenes+								
Nonanes+	128–205	14.56	20.50	0.793	1.4416			
Residue		2.36	3.86			6.50(a)		
		100.00	100.00			100.00		

Notes:—(a) Residue boiling above 130° C. (C_9 and up).
(b) To convert to densities at 25° C., subtract 0.008.

TABLE VIII
OCTANE NUMBER AND PROPERTIES OF DIMETHYL BUTANE FRACTION

Octane Number (unleaded) (ASTM)			94.5
A.P.I. Gravity			84.9
R.V.P.			9.5 lbs.
A.S.T.M. Distillation			
I.B.P.	116°F.	90%	121°F.
5%	119°F.	95%	122°F.
10%	119°F.	E.P.	131°F.
20%	120°F.	Rec.	98%
80%	120°F.	Loss	1.5%

the content of 2, 2-dimethylbutane in the hexanes is less. The high content of paraffins in the gasoline from once-through conversion indicates extensive alkylation, but not the primary alkylation of the circulation experiment. The high boiling products (C_9 and up) of once-through conversion are not only more abundant but more cyclic, as the high specific gravities show, and dark colored tar and considerable carbon were formed, in contrast with the products of the circulation conversion experiment.

While thermal polymerization of gaseous olefins to motor fuel ordinarily leads to the formation of a complex mixture of hydrocarbons, the use of favorable alkylation conditions makes possible the synthesis of isoparaffins of varying structure and molecular weight or volatility by the choice of suitable reactant paraffins and olefins. Such isoparaffins, particularly the more highly branched in structure, have high antiknock ratings and possess high stability, calorific value, and lead susceptibility. These characteristics are particularly desirable in aviation fuel. Iso-octane (2, 2, 4-trimethyl pentane) is now a familiar example.

The 2, 2-dimethylbutane, a hexane, is such a paraffin. This hexane was the chief paraffin synthesized by reacting together ethylene and isobutane. By fractionating a quantity of the liqui dproduct, a 2, 2-dimethyl butane fraction was separated for motor fuel tests. The data appear in Table VIII. The fraction was essentially paraffinic, containing 1.9 per cent olefin. The ASTM octane number of the fraction was 94.5 (unleaded), a little below that of isooctane, and the volatility somewhat higher.

(1) Keith and Ward, Nat'l. Petroleum News, **27**, 52 (Nov. 20, 1935).

(2) The experiments together with a discussion of the chemistry involved have been reported by Frey and Hepp, Industrial and Engineering Chemistry **28** 1439 (1936).

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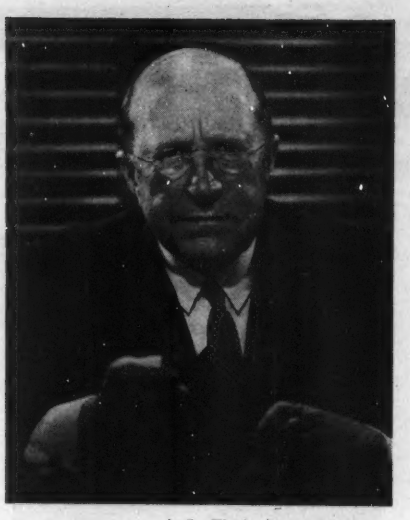
Oil and Gas Association Elects Officers for 1937

A. L. Weil, president of the General Petroleum Corporation of California, was elected to serve a second term as president of the California Oil and Gas Association at the December meeting of the Association board of directors. L. P. St. Clair, president of the Union Oil Company of California, and R. E. Collom, vice-president of the Continental Oil Company, were chosen vice-presidents. H. L. Westbrook, vice-president of the Belridge Oil Company, was re-elected treasurer for his 12th successive term.

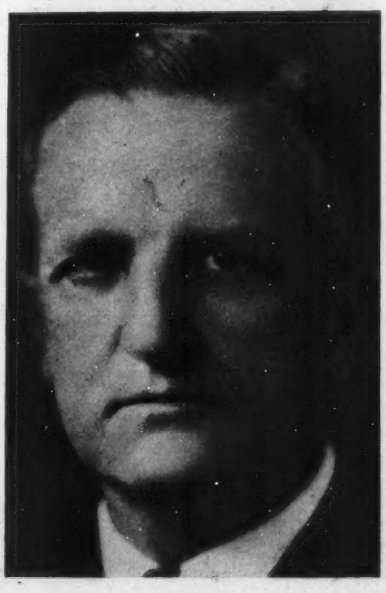
F. E. Foster continues as managing director, and D. S. Kilgour continues as assistant manager.

Directors elected for 1937 include: S. Belither, president, Shell Oil Company; Cyrus Bell, president, Perkins Cementing, Inc., R. A. Broomfield, president, Barnsdall Oil Company; W. H. Geis, president, Super Asphalt Products Company; E. B. Gilmore, president, Gilmore Oil Company; J. R. Hoffman, vice-president, Smith Booth Usher Company; Wm. F. Humphrey, president, Associated Oil Company; C. S. Jones, president, Rio Grande Oil Company; K. R. Kingsbury, president, Standard Oil Company of California; Ralph B. Lloyd, president, Lloyd Corporation; W. C. McDuffie, receiver, Richfield Oil Company of California; Alexander B. Macbeth, president, Southern California Gas Company; A. C. Mattei, executive vice-president, Honolulu Oil Corporation, Ltd.; C. E. Olmsted, president, The Texas Company (California); W. H. Reid, president, Hancock Oil Company of California; William Reinhardt, manager, Kettleman North Dome Association; F. C. Ripley, manager, Chanslor-Canfield Midway Oil Company; R. H. Taylor, president, Consolidated Steel Corporation.

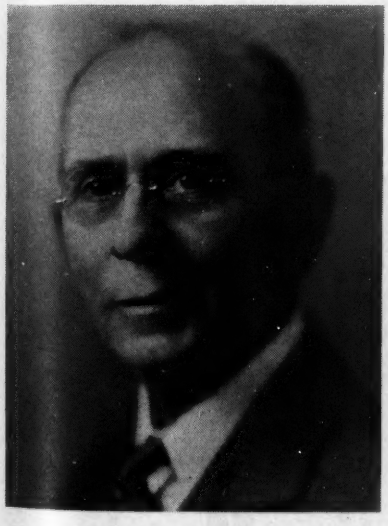


A. L. Weil

F. E. Foster



R. E. Collom



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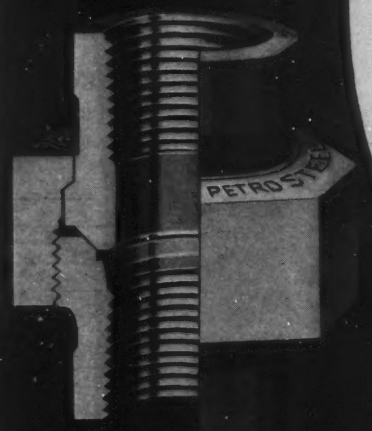

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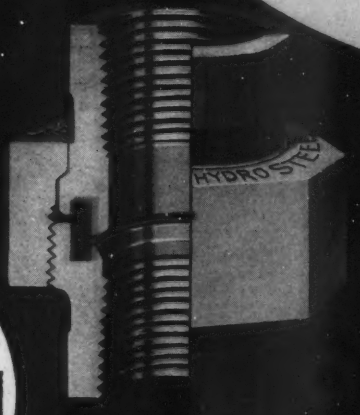

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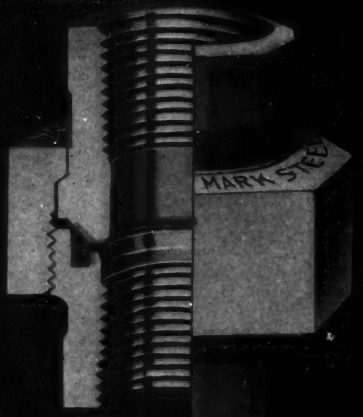

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Transportation

Accounting Methods For Tank Truck Fleets

By J. W. Sinclair
Union Oil Co.
A paper before the Petroleum Accountants Society.

The nearest approach a truck operator has to accounting is that he knows it costs so much to operate a truck, and if it costs more than that, then it's too much. If you ask how much it costs operate a truck, I really can't tell you, nor do I know anyone who can. The topography of the country over which the vehicle operates, the various service requirements, the charges which must be absorbed from various sources, all must be given consideration.

As the subject is to be tank truck operation, we naturally speak as one connected with the marketing department. For the information of any field men present, we graduated (or degenerated) from the intensely diversified occupation of operating oil field trucks a number of years ago; but our recollection of those days is still vivid. Unfortunately, I've been away from field trucking too long to comment with any accuracy on their present problems or practices, and refinements have doubtless occurred with the passing years. In those days, trucking was trucking, and to hell with the cost. If lightning struck a pump station, the only idea was to get there with a replacement. Nowadays in marketing truck operations, we must not only get the product to the customer, but we must do it with a nice pretty wagon, act like gentlemen during the entire process, and not let it cost too much. How much does it cost to deliver a gallon of gasoline? How old is Anne? You can't merely say 1c, 2c, 3c, 4c, or points upward,—you have to speak in terms of point quadruple naught etc., etc., and if your costs increase somebody is distinctly interested in knowing why.

Bearding the lion in his den, we boldly wade into accounting as applied to fleet operation. About 20 years ago, when we started out as a hammer-fit mechanic, I had about as supreme a contempt for a lead pencil as existed in this universe. If anybody asked me to make out a time sheet indicating whether I worked on the motor or the rear end I considered it an encroachment upon my privileges as an American citizen. Today I consider that any fleet operator who tries to operate without a basic background of good sound cost data is placing himself in the position of a ship without a rudder. He may be going places, but he doesn't know where. Somewhere through the years, and gradually, my attitude has changed in the degree indicated; and possibly this change is symbolical of the changes occurring in fleet operation as a whole during this period of time.

In speaking of accounting as applied to fleet operation, we advisedly touch only lightly upon the manner of accumulating cost accounting data. In practically all large organizations, the accumulation of fleet operating costs is a by-product of other necessary data, and the manner of collecting same is purely incidental to the topic at hand. We are interested purely in the extent of such data, and more important still, the manner in which it is used. Both the extent of cost data and its potential usage are dependent in a large measure upon the size of the fleet. Possibly the only safe generalized phrase to use is that such data should be adequate. It follows that what might be considered adequate for a limited number of vehicles, would be considered lacking in a number of respects for really large fleets; and it would most certainly be a ridiculous procedure for anyone operating only a nominal number of trucks to saddle his organization with data which might only indicate the trend based on the law of averages, and the very limited scope of his operations would prevent his "averages," from being representative or reliable.

However, regardless of the size of the fleet, we believe the accumulation of cost data should start from the bottom and deal with the individual vehicle; and again dealing with safe generalities, the break down of such costs may be restricted to the items of gasoline, oil, repairs, tires, and depreciation, plus any nominal segregations of expense items peculiar to the character of the fleet. The gasoline and oil segregations should indicate not only the volume consumed, but the cost thereof as well. If for any special reason more minute segregation of the items of repair expense is desired, same can of course be readily done; but in a general sense this is seldom necessary. However, to meet or counteract any condition giving promise of contributing to unwarranted costs, the repair item may be extended for limited periods in such a degree as to constitute a virtual time study of repair operations. As an example of this particular type of minute segregation, and the usage made thereof, we hark back about 10 years in our fleet, when the usage of a very complicated and voluminous form was inaugurated, and I think all members of our comptrollers department will shudder even today when I mention the old form 194X. The form in question was an analysis of repairs divided into 33 segregations. Every hour the mechanic spent on the vehicle throughout the month was recorded in an appropriate classification, and if continued indefinitely the procedure would naturally approach the ridiculous. However, the form was put into effect for the specific purpose of making time studies as related to shop operations, and during the first twelve months of build up, no definite steps were taken to interpret or use the

data so accumulated. We were merely waiting to secure representative figures over a representative period of time. Immediately this representative data was accumulated, the minute breakdown was discontinued. The usage made of this data? At the time the form was inaugurated we had 14 company owned and operated repair shops on the Pacific Coast in the Marketing Department. Today, we have only two major shops, and one subsidiary shop. Of course the data so accumulated was not the sole factor in such a change; but it furnished the sound starting point; and through the years the change was made gradually effective.

Having established for the individual vehicle a running monthly summary of the items mentioned, the next step is the build-up of same in several major classifications; in such groupings as geographical areas, makes and models, yearly vintages; and as in our case, by the types of tanks or mountings carried by the vehicle, the latter build-up being used for delivery studies, which will be commented on later.

I have commented very lightly on the item of fixed expense, except that of depreciation. Fixed expense items of a fleet such as our own, (the fleet being operated as a means to an end and not considered as an end within itself) are largely established by the general accounting procedures of the company as a whole, and as such are properly beyond the control of the automotive department. The fleet operator has plenty to worry about concerning items in a large degree within his control, so the better procedure is to forget in a large measure such items, except possibly to let out now and then cries of agony to the general effect that such charges are too much, regardless. In all probability nobody will pay any attention, but it's a safe way of letting off steam. The item of depreciation, however, is really of vital interest to the operator. The establishment of an adequate yet not excessive depreciation scale is essential, if depreciation costs are to be considered with relation to the mounting or decreasing maintenance expense of a vehicle or group of vehicles.

Once accumulated, what usage is made of such costs? Operating costs can be considered only as a history of past performance, a post mortem; but we know of no better way of anticipating what may occur in the future, than by a study of what has happened in the past. If we could positively feel that what has happened once will happen again, the application of operating cost data would be simple. The fly in the ointment is to distinguish between those items which have reasonable assurance of repeating themselves; and segregating those happenings that were definitely influenced by some temporary condition, which condition is not likely of repetition. And therein operating experience is injected into the interpretation. An attempt to scan operating cost data, and draw any conclusions therefrom without the leveling medium of operating experience, may easily result in some rather startling and inconsistent deductions. Hence we say that the value of operating cost data rests largely in the ability of the operator to properly interpret it.

The usage of operating cost data in our own fleet is two-fold; the individual vehicle is watched for mounting costs; and the group averages as to types, makes and models, and areas of operation, are periodically summarized. Group averages are used in assisting in the determination of replacement schedules as to types; we advisedly say, "assisting," as the very important factor of continued adaptability to present day delivery requirements, or obsolescence, is ever present and must be recognized. Time does not permit of any more detailed comments as to the usage of these group average studies; but the results may be boiled down into a composite picture of a fleet being segregated into three major groups, namely; those vehicles which from the standpoint of inadaptability to current requirements and increasing maintenance costs are candidates for retirement in the relatively near future; those vehicles which although not new are nevertheless adaptable, although nominal increasing maintenance costs are being experienced; and those vehicles of comparatively new vintage and limited mileage. From the first group retirement schedules are formed, and a bleeding process is followed during their remaining period of service. By bleeding we mean holding repairs to the minimum consistent with safe operation. Through this bleeding process maintenance economies are effected. The third group, being comparatively new, naturally operate with a minimum of maintenance expense. The second group may normally be expected to suffer increased repair costs. Hence, in effecting ultimate reductions in the general maintenance cost per mile, we are in reality playing both ends against the middle; in that economies effected in the first and third groups offset increases in the second group. We fully appreciate that the procedure may sound somewhat theoretical, and yet it has proven entirely practical and productive of

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operating economies over a wide period.

The usage of repair costs as to the individual vehicle, is naturally somewhat more restricted, and such usage is largely confined to the detection of increased repair expenditures, and the taking of the necessary remedial measures when same occurs. We emphasize that you can't repair a truck, or make it run any better or more economically solely through the use of a pencil. Only a competent mechanical maintenance personnel can accomplish this end, and the operating costs data merely serves to indicate the degree of competency, and in event of consistently occurring difficulties, indicates the necessity of remedial measures. Just what those remedial measures may be is strictly a maintenance problem, separate and distinct from the realm of accounting. Hence we wish to dispel any thoughts which may have been created that costs records take precedence over mechanical and managerial ability. Costs records are merely a means to an end, but nevertheless of invaluable assistance.

We have been dwelling at considerable length upon maintenance and operating costs per mile. Unless the fleet operator takes care to retain at all times the proper perspective he is liable to fall into the error of thinking that the truck is an end in itself, and not merely the means to an end. In any organization wherein the fleet is merely a necessary adjunct to the business itself, the purpose of such a fleet is to deliver as dependably, safely and economically as possible. If we tend to forget dependability, and safety, and the necessity of tying the delivery factor in with other major considerations of the company as a whole, the mania for economy of operation may prove a boomerang. As an illustration, if we view the sole objective of the operator as a minimum repair cost per mile, in our own fleet we could immediately affect substantial reductions in such repair costs per mile by merely bringing the vehicle to the shop, regardless of the distance involved, rather than consistently maintaining and repairing same on the ground of operation through the medium of regional or travelling mechanics. The latter procedure necessitates bringing the man to the truck, involving transportation for him, and living expense while away from headquarters; and in addition repair facilities on the ground are not as favorable as those in a well equipped centralized shop. However, the factors of lost truck delivery time and increased truck mileage would be ignored, and the eventual result would be a higher delivery cost per unit, more than offsetting any economies effected solely in maintenance costs per mile. The logical procedure is one established as a happy medium between two extremes.

I do not feel qualified to comment in any more detail on accounting procedure as applied to fleet operation. Inasmuch as the thought was expressed that we comment a bit on mainteance and operating problems peculiar to the tank truck operator, I'll unburden myself accordingly. The tank truck operator not only has those problems common to all mobile vehicles confronting him, but some peculiar ones of his own. In common with all vehicles, tank trucks have motors, differentials, transmissions and wheels; and when you have anything that rolls, you have grief. The maintenance procedure in our own fleet leans towards perpetual maintenance rather than periodic overhaul. Regional or travelling mechanics are assigned certain areas and made responsible for maintenance in those areas, thus establishing what might be called an outside-in setup. To as large a degree as possible, vehicles are kept out of divisional shops; the latter being restricted as largely as possible to major unit overhaul, such as motors, transmissions and differentials, as well as furnishing the base for directing the activities of the men in the field. Major units mentioned are exchanged in the field. We avail ourselves of commercial shop repair facilities to the extent of their ability and adequacy, and dependent upon the degree of isolation of the station at which the vehicle operates. In the major centers, although we maintain what might be called a permanent corps of men we use to a representative extent the facilities of commercial shops the criterion being generally expressed in the thought that if we can have a thing done on the outside as cheaply and dependably as we can do it ourselves, we do so, and then utilize the time of our own men in performing those functions which cannot adequately be cared for by commercial concerns.

We spoke of "perpetual maintenance," which no doubt raises a question in your mind as to whether such servicing is on a mileage or a calendar period basis. It is in reality a combination of the two, and to avoid overservicing, (the ever threatening evil of any perpetual maintenance system) skip stop servicing is frequently reverted to. The proper coordination of these two factors is one of the greatest problems of perpetual maintenance, especially where vehicles of somewhat widely diverging mileages are encountered in the same area.

Our painting procedures follow somewhat the same principle as mechanical maintenance procedures. The great bulk of our truck painting work is done on the ground, at the station where the vehicle operates, by a travelling painter equipped with spray equipment and a relief vehicle for usage by the station when the station truck is being painted. In any marketing fleet the question of presentability is an important one. Bearing in mind that the major objective is to keep them presentable to the man on the street, we work to just that end. In other words, except for the deluxe jobs operating in major centers, no "coach-finish" work is resorted to. The latter type of jobs are of entirely different calibre from the general run of our trucks, require special finishing, and surface maintenance by competent workmen.

In considering the problems peculiar to the tank truck, it must be appreciated that this type of vehicle is perhaps more intensely regulated than any other type. Possible the intensity of regulation is not fully appreciated by those not intimately associated with such operation. In addition to those governmental regulations accorded all trucks regardless of type such as local ordinances regulating truck traffic, state highway codes, highway patrols, boards of equalization, public utility commissioners, and of late even Federal regulations; the tank truck is faced with local and sometimes state regulations peculiar to its type. Fortunately, this multiplicity of regulations in general centers around the specifications of the National Fire Protection Association's code with regard to tank truck operation, and has to do with the gauge of the metal and its characteristics as used in the tank, the provision of longitudinal and trans-

verse baffles, tank venting both from a vacuum and internal pressure angle internal valves, the types of flow lines and methods used in construction, remote controls, ignition controls, fire extinguisher equipment, delivery methods, size of compartments, segregation of commodities, etc. Notwithstanding this authoritative base, however, it is a constant problem to construct a tank vehicle which will meet the requirements of all areas in which it may operate; as some governmental agencies persist in injecting into their regulations requirements which, mistakenly or otherwise, they consider as being necessary in their own area.

No matter how cheaply a vehicle operates per mile, unless it is used properly from a delivery standpoint in such mileage all other economies are more than offset, and a high delivery cost results. Delivery supervision begins with the initial equipping of the vehicle, and its proper assignment for usage thereafter. A tank is a peculiarly inflexible thing. Once you construct it you have something that is going to be with you for some time to come, so extreme care must be exercised primarily as to its capacity and the adaptability of that capacity to the area in which it is to operate. If it is too large, you are not only carrying around more dead weight than is necessary, but you are also inviting excessive hack-haul to the plant. If it is too small, excessive truck mileage results from too many trips back to the plant for additional loads. Naturally in a large fleet, changed delivery requirements throughout the life of a vehicle are offset by checkerboarding or interfleet transfers, to assure to the greatest possible degree the proper usage of the vehicle throughout its life.

Delivery supervision is assisted in our own fleet by the maintenance of delivery performance records for each vehicle, indicating in addition to the mileage travelled, the number of trips made, the gallonage hauled, the hours worked, and the number of deliveries made. The general criterion of delivery performance is the number of units delivered per mile of truck travel. It is naturally impossible to state definitely how many units a vehicle should deliver per mile of truck travel, as the size of the vehicle, the nature of the trade served, the area served, etc., are influencing factors which can be best determined only by surveys of such areas. In such surveys largely rests the most prolific source of delivery economy. We use our individual and accumulative delivery performance data as guides to the surveyor as to the results actually accomplished, and he determines, largely on the ground, whether through rerouting, change in vehicle types, etc. how such performance may be bettered. In our own fleet these men are called Division Delivery Supervisors and their activities are one of the most important contributions toward the improved delivery performance brought about over several years past. In delivery supervision, as in maintenance supervision, experience data forms the guide, and the actual accomplishment of any betterment is through the medium of proper interpretation of such data, and its following up by experienced and capable supervisors.

What truck chassis to use? Again we can deal only with the generality that they must be of adequate capacity, and amply powered to meet the operating requirements of the area in which the truck is stationed. In considering adequacy of power, the topography of the country is of prime consideration. However, when dealing with vehicles subject to transfers over wide areas, a general criterion in this respect can be established with a fair degree of surety. In dealing with power requirements with relation to the gross load to be carried, we use as a criterion the pounds of gross weight carried per cubic inch of motor displacement. I make this statement in full realization that from a technical standpoint it is a vulnerable one; yet from the standpoint of generalized and practical application it is nevertheless sound. We purposely refrain from mentioning the horsepower of the motor, for the reason that such ratings are frequently misleading and are based on the assumption that the user can utilize the maximum brake horsepower developed even though it is developed at a motor speed far beyond ordinary and practical application. For example, a well known type of motor is rated at a given brake horsepower, but such rating is based on an exaggerated number of revolutions per minute. The standard transmission gear reductions, and rear axle gear reduction, together with the minimum sized tire which can be used with the rated load, would produce a speed of 58 miles per hour at the motor RPM at which the rated BHP is obtained. The impractical speed is evident in normal usage. Even assuming that a normal speed might be considered at the somewhat high figure of 40 miles per hour, we find that at the corresponding motor speed, the BHP has been reduced nearly 30 per cent. We prefer to rely on motor torque, and in so doing again find a somewhat consistent ratio of torque to motor displacement, which brings us back to our original criterion of judging the performance ability of a motor, from a practical standpoint at least, by the size of the cylinders and the number of them. The ratio of gross load to motor displacement naturally varies according to the flexibility desired of the truck. In our own fleet, this ranges from as low as 50 to as high as 95. However, we find elasticity somewhat impaired if the latter figure is exceeded.

What make of truck to use? More today than ever before, the truck user is assured of getting more nearly his dollar's worth in this regard. Insofar as the individual user is concerned, a wide field of selection is open, as practically all truck manufacturers are turning out good jobs; and in practically any make may be found models to suit practically any condition, restricted of course to the range of the manufacturer. Nominal advantages in specification, design, etc., sometimes accrue to one manufacturer over a limited period, but the field today is so highly competitive that an outstanding advantage in this respect is not retained by any one manufacturer over any great period. Other important considerations enter, however when the vehicle becomes a unit in a fleet operating over a wide area. There must be a definite degree of assurance that the adaptability and dependability of the vehicle will not later suffer through lack of service facilities and parts facilities by the manufacturer over the areas in which the vehicle may operate. In the event any technical difficulties are encountered outside the range of ordinary maintenance, service and engineering assistance should be available.

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BAKER ROTARY WALL SCRAPER

Now that Christmas has came and went, and the novelty of wearing a new set of garters has begun to pall, Bob Angel is seriously of the opinion that something ought to be done about these people who are everlastingly exceeding the feed limit.

You know of course in this connection that an adult is a person who has stopped growing at either end but not in the middle.

And Roy Fry, logically enough, thinks it is a great sign of the return of prosperity that people are again beginning to boast of their gains instead of their losses.

Jumping now from the ridiculous to to the more ridiculous: Bill Moeller is our authority for the fact that two gasoline plant operators recently became involved in an argument on the subject of polymerization. They, however, arrived at no definite conclusion. In fact, after the argument, one of the boys arrived at the hospital, and the other arrived at the county jail.

Polymerization, by the way, is explained by experts as a process of making little ones out of big ones, something which Junior, our precocious offshoot, has always managed very nicely with a common or garden hammer.

Dub Russell is rightfully somewhat distressed over the prevalence of profanity on the golf course. "It doesn't help the game a bit," he says, "The players who get the low scores don't swear." "Heck, no," replies Ed Leabow, "What have they got to swear about?"

On the other hand, when Phil Rockfellow read that a man had recently received a heavy jail sentence for demanding money with threats, he remarked, "Gee, I hope my landlord reads this."

Phil had a very good day at the Chevy Chase golf course last Saturday. He broke a hundred, and a plate glass window in the club house.

Herb Egglestone tells now a sad story about an efficiency expert, who died as all efficiency experts must eventually, and while the casket was being carried into the church, he woke up long enough to remark, "If you birds would put rollers on this thing, you could lay off about four men."

And says a well known rousty to the hardware man, "Gimme a mouse trap quick, I've got to catch a bus."

Just once in a long time a little bit of humor creeps into an accident report. For instance, Andy Anderson recites the case of a pumper who turned in a detailed story of an accident in the required manner, and then kicked through a few days later with the following correction: "The cow which I killed with my auto on December 24 was a horse, and it ain't dead yet."

Also, according to Joe Dunn, when the oilmen's High-Jinks was going full blast at the Biltmore recently, a lady called on the phone and inquired of the porter who answered, "Is my husband there?" "No, ma'am," he replied very emphatically. "How do you know?", she came back indignantly, "I haven't even told you who I am yet." "That doan make no diff'ence, lady," insisted the diplomat, "Thay ain't nevah nobody's husban' heah."

Which shows that maybe after all the little boy was right when he described matrimony as a "place where souls suffer for a time on account of their sins."

And the following conversation was heard by Red Wilson in a company boarding house: 1st Rousty: "When are you gonna gimme back my tie?" 2nd Rousty: "I haven't got it any more. I traded it last week for one of my own."

Reminding us of the guy who gave his buddy ten dollars to invest for him at Santa Anita. When the plunger returned he apologized for losing the entire sum, and explained that he had had such an unlucky day, he almost lost some of his own money.

An Italian scientist is said to be working on an anti-aircraft ray that will paralyse the ignition of a motor. Bill Robinson says he has been able to get the same effect by simply leaving the key in the ignition all night.

George Thompson interrupts here to tell us about a lone golfer who walked up to the Polvadero club house. When the clerk asked his name, he replied, "Nicholas Johnston Watkins McAllister." "Sorry, sir," was the reply, "We have no room for another foursome."

"Lend me four bits," said the linewalker. "No, sir," answered Frank Coyle, "Borrowing money is the surest way to lose a friend." "Aw, never mind," says the linewalker, "Gimme the four bits, and I don't care if you never speak to me again."

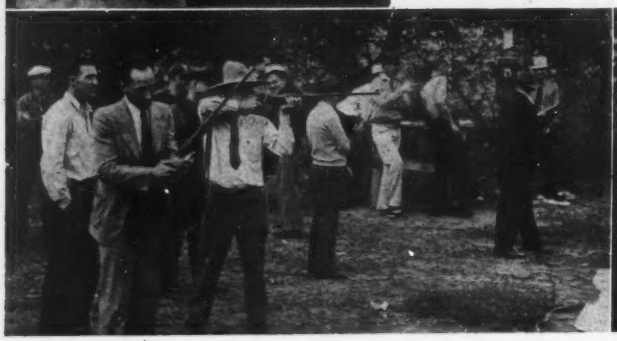
And it's a fact that many a true word is spoken in jest. According to an announcement in a local paper, the offices of a certain oil firm, well known to both of us, were closed on Thursday, December 24 "for altercations."

Union Oil Turkey Shoot

The Union Oil Company Turkey Shoot, held Dec. 13 at Brea Canyon range, was attended by more than 100 shooting enthusiasts.

Prizes of turkeys were won by 34 contestants, while two others literally "brought home" slabs of bacon.

The camera's eye catches some of the trigger men in action. At the left, top, we see L. A. Metcalf, manager of refineries, presumably destroying a target. Just below him is A. C. Rubel, director of production. In the lower left corner Ken Kingman draws a bead on the target while in the background may be seen Clarence Froome, R. D. Gibbs, Jim Hill and L. A. Metcalf. To the right we have a view of Mrs. H. Grinnell as she pays her Gun Club dues to Ray Tatum and Howard Said.



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California Board of Equalization Waging Campaign Against "Drip" Gasoline Use

The State Board of Equalization has recently started a campaign to stop the producer of oil from getting drip gasoline from the gas lines of his wells. The Board maintains, and correctly, that within the meaning of the law under which it operates, any natural gasoline so acquired, and used, is subject to the state gasoline tax of three cents per gallon, and that the producer must have a license as a distributor of motor vehicle fuel to take this gasoline from his lines and use it.

Inasmuch as no oil producer has such a license, and inasmuch as it has been customary among smaller operators to use this gasoline for whatever purpose it is needed, including the washing of the clothes of the crews, the washing of tools, etc., as well as in trucks and in some automobiles, the new activity of the Board has caused considerable consternation. Cases of assessments of as much as $600 are known to have been made, on the basis that a penalty of 100% of the tax is due as well as the tax itself.

The justification for the penalty tax, according to the Board, lies in the fact that the producer falls within the classification of a distributor of gasoline, under the law, and the penalty for a distributor's not having a license is 100%, plus his inability to claim exemption from the tax to the amount of the gasoline used for other than motor-vehicle purposes. For that reason, even though the producer did not use the gasoline in his trucks or automobiles, he still would have to pay the three-cent tax on all drip gasoline, plus a three-cent penalty on each gallon he has used.

The Board, in its investigations, makes every effort to find out how long the drip has been on the line, and how much gasoline it produces per day, thus estimating the number of gallons of gasoline upon which to assess the tax.

The matter was brought to a head for a number of reasons, among them being the prodding applied by independent refiners who saw their gasoline being taxed, complete records of their production being made, and at the same time saw this drip gasoline going tax-free. Another factor was that, when the Board's auditors went into the books of the independent refiner, as is customary and legal, to determine the amount of tax he should pay, they found that "natural gasoline" ("drip" gasoline in this case) was being bought in truck and trailer loads of 6000 gallons. Further investigation as to where these loads originated proved to be futile, and the upshot is the current drive either to make the producer take out a license as a distributor and keep the required books, or remove from his natural gas line the various "drip" devices which have been installed. In the background has been the knowledge of the Board of the existence of these devices for a number of years, action being demanded by the growth of the practices and complaints mentioned above.

Investigation among the major companies shows that they all have stringent rules prohibiting the use of this gasoline by their employees, in most cases the rules being backed up by a lock on the drips themselves. For that reason, the majors have as yet not been forced to pay any back taxes. As a matter of fact, the Board's most fertile field has thus far proved to be the operator of but a few wells, who, in many if not all cases, was entirely unaware that he was breaking the law.

A careful reading of the law, however, shows that the user of this gasoline, in whatever way the gasoline may be used, is, within the meaning of the law, a distributor of gasoline, and therefore is subject to the rules and regulations governing distributors of gasoline. These rules include the purchase of a proper license, the posting of a bond, the keeping of proper records, and various other items. Penalty for not complying with the law is that the distributor has no opportunity of declaring any of his gasoline to be tax-free because of non-highway uses, the imposition of a 100% penalty, and in extreme cases, the imposition of a fine or a prison sentence, or both.

The Board's campaign to control drip gasoline is at its height at present, field men being especially active in the Basin fields.

If the producer desires to keep himself clear of infractions of the law, he has two alternatives: purchase a distributor's license and keep the records required of a distributor, paying the tax on all such gasoline as is taxable, or remove any and all drip devices from his natural gas lines.

Larson Buys Refinery

G. A. Larson, independent refiner from Pennsylvania-New York, has bought one of the idle refineries at Hynes, and plans to go into business as a California refiner. He expects to overhaul and renovate the plant and start commercial operations within a few weeks.

Mr. Larson's last operations were at Warren, Penn., where he owned a a refinery making lubricants and gasoline. He has, however, operated in other parts of the Appalachian oil fields.

Three Wildcats Planned For Locations In Antelope Valley

Three wildcat wells will be drilling in the Antelope Valley within the next 30 days, if present plans are carried out. Wm. Diller, land owner, is already starting one with a No. 5 portable rig on sec. 1, 5s-11w., about five miles southeast of Palmdale, where he hopes to get oil between 500 and 800 ft. The other two wells will be drilled by the Neucal Oil Co., and G. A. and P. O. Hammon, former Oklahoma-Kansas operators, now residents of Los Angeles.

Backed by Santa Barbara and San Francisco capital, the Neucal Oil Co. has acquired some 5000 acres, and expects to be at work by Feb. 1 on its first well to be drilled on the ne¼ne¼ sec. 17, 6n-12w, 1½ miles northwest of Palmdale. J. G. Wheeler of Santa Barbara will be in charge of the drilling. Number 5 rotary equipment will be used and a 136 ft. wooden derrick erected. Commercial oil is anticipated around 3500 ft.

On the se¼ne¼ sec. 9, 6n-12w, half a mile northeast of the Neucal's drill-site, the late John B. Harding drilled about 10 years ago to a depth of 1842 ft. Reports then were that oil signs were found from 1200 ft. down—shales cutting oil, some gas, and small streaks of oil sand. But the pipe froze, the financial backers withdrew support, and the enterprise had to suspend. Neucal chose its drill site largely upon the strength of the Harding well's showings.

Hammond Brothers will drill their well on sec. 21, 6n-12w, which adjoins on the southeast sec. 17, where Neucal will drill its well. The Hammon property is a sublease from Neucal. They hope for results between 2100 and 2400 ft.

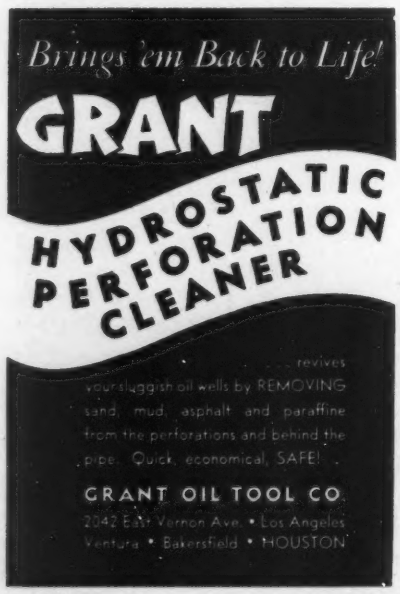
Neucal figures that it is on a structure about three miles long and 1½ miles wide, lying between the great San Andreas fault which runs northwest and southeast, 1½ miles south of Palmdale and an unnamed minor fault running north of Palmdale. The Diller location is south of the San Andreas fault. A third fault runs along the line between townships 6 and 7 in range 12w. These faults and others in the northern end of the valley are shown on a new map published by the U. S. Geological Survey, advance copies of which have been received from Washington.

For many years there was a widespread belief that Antelope Valley was of continental formation and therefore hopeless for oil. Recent studies have uncovered marine fossils and they are mentioned in Ralph Reed's volume on California geology. Dr. Gerrard Henny has also found shells and fossils showing a marine formation. A few early wells went close to 4000 ft. without striking granite. This depth has been reached at the present time by the Regina Oil Co's wildcat in the extreme north end of the valley at Willow Springs. A few miles west of the Regina well another was drilled to 4100 ft. a few years ago by the Meridian Oil Co. of Fullerton. Its backers were confident that they had good oil prospects and some of their cores looked good.

However, most of the wells drilled at various sites over Antelope Valley were located on limited geological knowledge or by "doodle bug" methods, and were poorly drilled to comparatively slight depths with inadequate finances.

Rio Bravo Locations

Standard Oil Co.'s discovery well at Rio Bravo has resulted in plans being made for three more wells in this area. As yet locations have not been made. The discovery well is now flowing at the rate of 242 bbls. per day of 37.1 gravity oil cutting 1.1%, through an 8/64th inch bean.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Montebello Extension Sought

Further extension east and southeast of the Montebello field, or the possible opening of a new field, may result from the leasing of the 1500 acre Anita Baldwin ranch by the Danciger Oil & Refining Co. of California, susidiary of the Danciger Refineries, the parent corporation of the Danciger interests.

The first well will be drilled at once at the center of sec. 11, 2-11, about 1000 ft. south of where Shell drilled to 4563 ft. in 1922. Although abandoned as non-commercial, the Shell well has been declared by men who worked on it to have had oil and to have shown sufficient encouragement to justify deeper drilling today. The new drill-site is also some 4000 ft. northwest of an old well drilled by "Lucky" Baldwin to 1900 ft. The drilling was done some 30-odd years ago. A gas blow-out set fire to and destroyed the derrick and wrecked the hole. Gas, which burns readily, and sulphur water still come from the wrecked hole. Fay L. Wright, geologist, passed favorably upon the prospect for Danciger.

The Danciger lease is considered a probable extension of the unusually shaped Montebello field. It lies east of the extension which has been already proved by Universal, Richfield, Texas and others, and turns more to the southeast. It covers parts of secs. 1, 2, 3, 4, 10, 11, 12, and 14, in twp. 2-11. On the southwest, it is bounded by part of the old Central Oil Co. 2200-acre fee property lying in and east of the old Whittier field. Years ago Central leased its wells and the southern part of this land on which they are located to Standard Oil. However, Central, no longer active, still owns the southern part of its land which adjoins the Danciger lease. Nearly 30 years ago Central drilled a test hole to 3839 ft., a very deep well for that period. It had some oil but nothing of commercial value. If drilled today this well would be carried much deeper. This abandoned well is situated about 1½ miles southwest of the Danciger drill site. Central has done no drilling for more than 20 years, neither has the northern part of its land been leased for drilling.

Flood District Lease Refused

Los Angeles County Supervisors will not lease lands of the County Flood District along the Los Angeles river from Willow Street to the ocean for oil drilling, or at least not now. They have refused the request of Arthur S. Ferguson that such a lease be offered for sale. No reason for the refusal was given.

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California Production 17,465,315 Bbls., 582,077 Bbls. Daily, During November

November production in California totaled 17,465,315 bbls., a daily average of 582,077 bbls., according to final figures of the A. P. I. These figures compare with a total of 17,-942,030 bbls. during October, and a daily average of 578,775 during that month. The decrease in total production in November as compared with October was 479,715 bbls., while, because of the extra day in October, November's daily average increased 3302 bbls. Daily average during November, 1935, was 676,476 bbls., 94,399 bbls. more than the average for November, 1936.

Stocks of all products at the end of November totaled 130,211,305 bbls., a decrease of 774,465 bbls. During the year to the end of November, stocks of California oil companies decreased 417,341 bbls.

The modest increase of 3302 bbls. in the daily average of November as compared with October was accounted for by small increases, practically all of less than 1000 bbls. each, in several fields. Among the fields to show such increases were Midway-Sunset, in the Valley, Ventura Avenue, on the Coast, and Dominguez and Santa Fe Springs, in the Basin. Some of the fields showed decreases, but in general, variations were of such minor import as to make unnecessary a detailed analysis.

As compared with production in November, 1935, which was 94,399 bbls. more than production during November, 1936, greater variations naturally are shown. Decreases in 1936 are shown by Coalinga (5086 bbls.), Kettleman North Dome (33,015), Lost Hills (1205), McKittrick (2,-485) Mountain View (16,584), Elwood (4399), Santa Barbara (1326), Ventura Avenue (5184), Brea Olinda (2185), West Coyote (2224), Huntington Beach (8242), Inglewood (1911), Long Beach (14,295), Playa del Rey (5770), and Santa Fe Springs (9107). These decreases total 113,018 bbls., or more than the total decrease for the year. The discrepancy is made up by increases in North Belridge, Fruitvale, Midway-Sunset, Round Mountain, San Miguelito, Santa Maria, Dominguez, Montebello, Torrance, and the new fields, 10 Sections and El Segundo, the first of which produced an average of 1181 bbls. per day during November, 1936, and the second, 377, against none at all during November, 1935.

With the exception of non-gasoline-bearing crude, residuum, gas and diesel oils, which gained 288,916 bbls., all other classifications of stocks decreased during the month. The total decrease was 774,465 bbls., Nov. 30 stock figures being 130,211,-305 bbls. as against 130,985,770 bbls. on Oct. 31. On Nov. 30, 1935, total stocks were 126,250,063 bbls., showing a gain of 3,961,242 bbls. during the 12-month period from November, 1935 to November, 1936. This gain has occurred in stocks of non-gasoline bearing crude, etc., and in gasoline, in the first of which the gain was 6,734,945 bbls., and in the second, 1,554,422. Decreases in other classifications, including gasoline-bearing crude, unblended natural gasoline, naphtha distillates, and miscellaneous, account for the total gain of but approximately 4,000,000 bbls.

The gain shown in non-gasoline-bearing crude is probably in large part due to the fact that during 1936, no contracts for fuel oil were in existence with purchasers on the Atlantic seaboard. In the previous year, many companies held these contracts at prices which netted them no profit, but stocks of this commodity were so high that almost any method of disposing of them was found advantageous. During 1936, however, different conditions have prevailed, and none of the Pacific Coast companies were inclined to sacrifice their fuel oil stocks without getting a profitable return from them.

In field development, both the number of new rigs erected and the number of active drilling wells during the month decreased, while there was an increase of two in the number of producers completed. New rigs erected during November totaled 93, 16 less than October's total of 109. Active drilling wells numbered 248, seven less than October's 255. Completed producers totaled 71, all oil and no gas wells, as against the October total of 69.

Total initial production of the 71 new wells was 24,950 bbls. per day, an average initial of 351.4 bbls. per well per day. During October, the 69 wells had an initial of 415.8 bbls. per well. Initial production of wells completed during October, therefore, was 64.4 bbls. greater than that for wells completed during November.

Of the 71 completions during November, 34 were in the fields of the San Joaquin Valley, 13 were on the Coast, and 24 in the Los Angeles Basin. No gas wells were completed during the month. The leading single field, insofar as completions are concerned, was Midway-Sunset, where the 10 completions totaled 3384 bbls., or 338.4 bbls. per well, in initial production. Two fields, Kern River and Torrance, each had six completions, the first for an initial of 1054 bbls. (176 per well), and the second, 931 bbls. (155 per well). Five fields saw four completions each, Fruitvale, Mt. Poso, Round Mountain, Capitan, and Santa Fe Springs.

PRODUCTION DEVELOPMENT

(Figures of Production and Stocks are in barrels of 42 Gals.)

	Total Production November	—DAILY AVERAGE— Nov., 1936	Oct., 1936	Nov., 1935
Group No. 1—				
Belridge—North	406,000	13,533	15,140	10,204
Belridge—South	56,067	1,869	1,863	2,477
Coalinga	471,969	15,732	15,070	20,818
Edison	170,487	5,683	5,917	5,349
Elk Hills	248,111	8,270	8,175	9,751
Fruitvale	268,223	8,941	9,299	6,643
Kern River	435,754	14,525	13,746	14,365
Kettleman Middle Dome	8,039	268	291	.....
Kettleman North Dome	2,328,201	77,607	77,903	110,622
Lost Hills	108,385	3,613	3,758	4,818
McKittrick	52,926	1,764	1,777	4,249
Midway-Sunset	1,859,384	61,979	59,502	59,867
Mountain View	659,958	21,999	22,429	38,583
Mount Poso	540,669	18,022	17,751	17,838
Round Mountain	346,527	11,551	11,837	7,931
Ten Section	35,446	1,181	835	.....
Wheeler Ridge	10,279	343	343	393
Group No. 2—				
Capitan	53,886	1,796	1,539	2,020
Elwood	349,978	11,666	11,721	16,065
Rincon	63,683	2,123	2,270	2,082
San Miguelito	66,416	2,214	2,067	1,001
Santa Barbara	27,169	906	978	2,232
Santa Maria	159,741	5,325	5,041	3,921
Summerland	1,073	36	34	25
Ventura Avenue	1,029,277	34,309	33,728	39,493
Ventura-Newhall	149,645	4,988	4,740	4,344
Watsonville	1,800	60	60	60
Group No. 3—				
Brea-Olinda	241,503	8,050	8,145	10,235
Coyote—East	85,554	2,852	2,573	2,816
Coyote—West	235,418	7,847	7,990	10,071
Domingues	759,526	25,317	24,874	24,260
El Segundo	11,317	377	381	.....
Huntington Beach	1,053,052	35,102	35,256	43,344
Inglewood	374,286	12,476	11,909	14,387
Lawndale	3,143	105	80	307
Long Beach	1,962,480	65,416	65,530	79,711
Los Angeles-Salt Lake	24,508	817	810	815
Montebello	273,287	9,110	9,772	7,032
Playa Del Rey	329,579	10,986	11,505	16,756
Potrero	8,708	290	266	325
Richfield	212,877	7,096	6,984	7,671
Rosecrans	66,938	2,231	2,329	2,693
Santa Fe Springs	1,355,574	45,186	44,217	54,293
Seal Beach	262,774	8,759	9,241	8,739
Torrance	264,801	8,827	8,217	6,783
Whittier	27,897	930	882	1,087
Total	17,462,315	582,077	578,775	676,476
October	17,942,030	578,775		
Increase	479,715	3,302		

*Decrease

	New Rigs Up	Producers Active Drilling	Producers Completed	Daily Initial Output	Active Producing	ABANDONED WELLS Drillers	ABANDONED WELLS Producers
Group No. 1—							
Belridge—North	1	4	1	2,685	37	....	....
Belridge—South	..	....	....	....	175	....	....
Coalinga	..	4	1	6	850	....	9
Edison	..	2	....	....	89	....	....
Elk Hills	..	....	....	....	152	....	....
Fruitvale	5	7	4	739	125	....	....
Kern River	12	13	6	1,054	1,281	....	....
Kettleman Middle Dome	..	1	....	....	3	....	....
Kettleman North Dome	1	18	....	....	131	1	....
Lost Hills	2	3	1	35	275	3	....
McKittrick	..	4	....	....	132	....	....
Midway-Sunset	14	23	10	3,384	2,341	5	2
Mountain View	3	10	3	350	169	1	....
Mount Poso	7	7	4	855	238	2	....
Round Mountain	1	4	4	1,358	113	1	....
Ten Section	1	4	....	....	2	1	....
Wheeler Ridge	..	....	....	....	26	....	....
Group No. 2—							
Capitan	..	1	4	2,085	29	1	....
Elwood	..	....	1	996	76	....	....
Rincon	1	....	....	....	29	....	....
San Miguelito	..	2	2	585	10	....	....
Santa Barbara	..	....	....	....	57	....	1
Santa Maria	4	12	1	170	195	....	....
Summerland	..	....	....	....	19	....	....
Ventura Avenue	..	6	2	2,046	242	....	....
Ventura-Newhall	2	16	3	224	565	....	1
Watsonville	..	....	....	....	7	....	....
Group No. 3—							
Brea-Olinda	..	2	....	....	357	....	....
Coyote—East	2	3	....	....	76	2	....
Coyote—West	..	....	....	....	44	....	....
Domingues	1	5	3	4,723	119	....	....
El Segundo	1	1	....	....	3	....	....
Huntington Beach	7	15	2	665	517	....	....
Inglewood	..	1	1	430	200	....	....
Lawndale	..	....	....	....	6	....	....
Long Beach	1	....	1	120	1,241	1	5
Los Angeles-Salt Lake	..	....	....	....	122	....	....
Montebello	..	2	3	576	196	....	....
Newport	..	1	....	....	....	....	....
Playa Del Rey	..	4	1	84	213	....	....
Potrero	..	....	....	....	10	....	....
Richfield	5	6	2	390	259	....	....
Rosecrans	..	....	1	35	77	....	....
Santa Fe Springs	..	2	4	424	625	....	2
Seal Beach	..	....	....	....	102	....	....
Torrance	4	8	6	931	520	....	....
Whittier	..	....	....	....	158	....	....
Miscellaneous Drilling	18	54	....	....	....	9	....
Group No. 4—Gas Fields—							
Buena Vista Lake	..	....	....	....	....	1	....
Buttonwillow	..	....	....	....	7	....	....
Chowchilla	..	....	....	....	....	....	....
Delano	..	....	....	....	....	....	....
Dudley Ridge	..	1	....	....	....	....	....
Goleta	..	....	....	....	....	....	....
McDonald Island	..	1	....	....	....	....	....
Rio Vista	..	1	....	....	1	....	....
Semi-Tropic	..	....	....	....	....	....	....
Tracy	..	....	....	....	6	....	....
November	93	248	71	24,950	12,227	28	20
October	109	255	69	28,693	12,133	19	10
Increase (*Decrease)	16*	7*	2	3,743*	94	9	10
Average for year 1935	86	243	64	55,082	12,136	29	17
Average for year 1934	53	196	38	46,553	11,053	21	17
Average for year 1933	30	124	21	22,842	9 199	14	18

STOCKS HELD IN PACIFIC COAST TERRITORY BY CALIFORNIA OIL COMPANIES

	Nov. 30, 1936	Oct. 31, 1936	November Changes	Nov. 30, 1935
1. Non-Gasoline-Bearing Crude, Residuum, Gas and Diesel Oils	73,628,773	73,339,857	+ 288,916	66,893,828
2. Gasoline-Bearing Crude	33,680,672	33,874,512	— 193,840	37,650,566
3. Unblended Nat. Gas	1,881,460	1,965,151	— 83,691	1,504,890
4. Gasoline (not including distributing and service stations)	11,142,817	11,470,745	— 327,928	9,588,395
5. Naphtha Distillates	1,788,556[1]	1,880,125[1]	— 91,569	1,460,073[1]
6. All Other Stocks	8,089,027[2]	8,455,380[2]	— 366,353	9,152,311[2]
TOTAL	130,211,305	130,985,770	— 774,465	126,250,063
[1]Estimated amount of unfinished gasoline contained in item 5	1,462,241	1,526,703		1,016,103
[2]Coke included in item 6	261,448	282,992		472,099

Arkelo Coring at 7200

Arkelo No. 41, Arkelo Petroleum's wildcat in Kern county is now coring ahead just below 7200 ft. in hard shale in which are some streaks of sand. It is reported that strong gas showings are being found in the sand streaks.

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